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THE TRANSATLANTIC COMPANY'S NEW STEAMER LA NORMANDIE.

THE Transatlantic Company, through the beauty, size and speed of its vessels, as well as through its perseverance in following all the progresses of science and of the nautical art, is, with the Compagnie des Messageries Maritimes, the most powerful of our enterprises in navigation. It has just launched a new packet boat, La Normandie, to run between Havre and New York. This vessel, when finished, will be the most colossal of the ships comprised in the French commercial fleet. Our engravings give a general view and section of her, and of her appearance at the time of launching. She measures 160 meters in length, 15 in maximum breadth, and 11·4 in depth from deck to keel, and exceeds, by 15 meters, the largest steamers now in service. The author of the plans of La Normandie is M. Audenet, an engineer of the French navy, and chief of the constructions and technical service of the Transatlantic Company, under the direction of M. Eugene Pereire, President of the Company's Council Board.

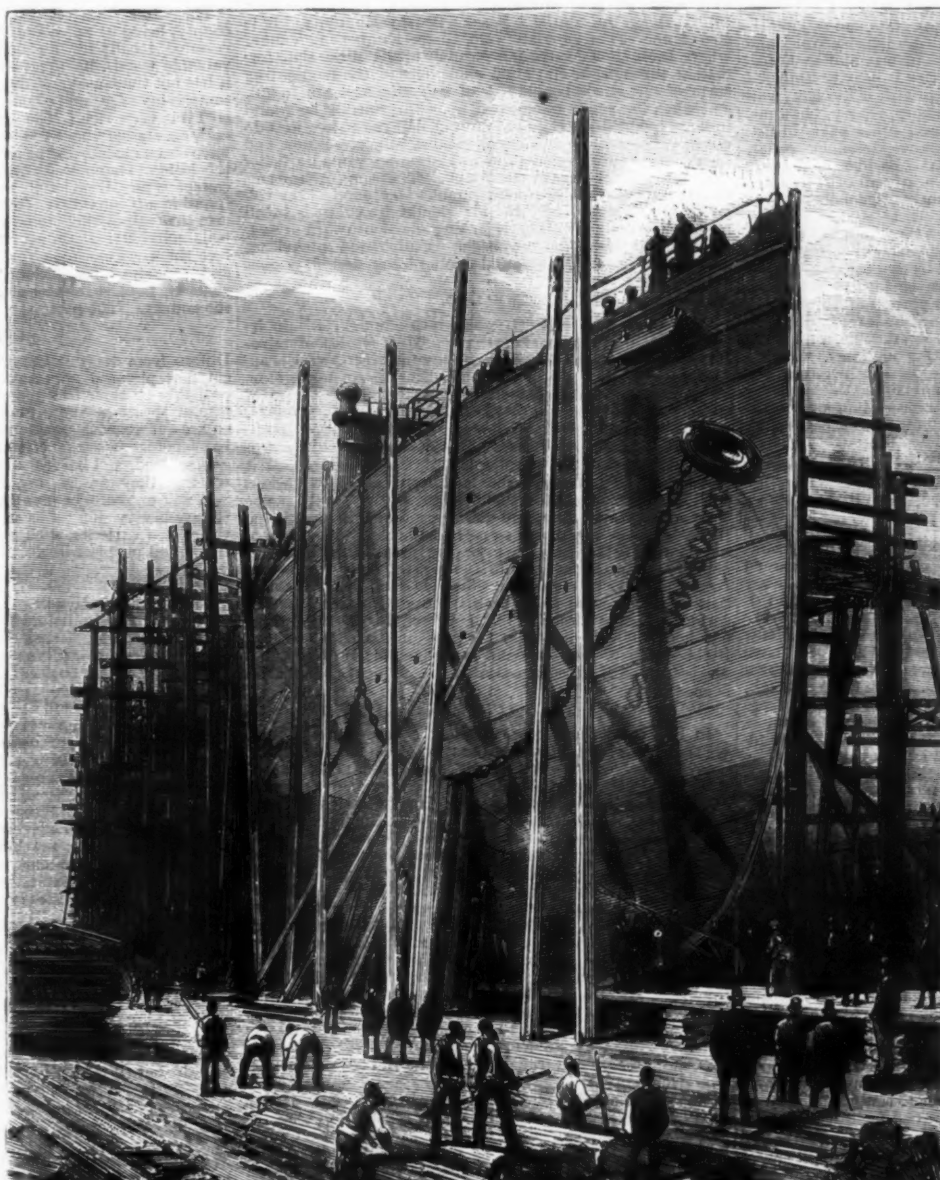
The immense hull, which tapers off forward like an ax-blade, is divided vertically into ten iron water-tight compartments. The decks are four in number.

The engines for propelling the vessel are three in number, giving an effective power of 6,600 horses, and actuating the screw so as to give a speed of 29 to 30 kilometers per hour. On board of La Normandie steam is a sovereign mistress; for not only does it serve to propel the ship, but through the intermedium of special engines distributed at different points, it actuates the pumps, the maneuvering apparatus, and the apparatus for loading, unloading, etc.

The masts, which are of iron, are four in number. The two fore ones carry square sails set on low steel yards, while the other two carry less sail.

La Normandie is the last packet boat that will be demanded of England, since hereafter the vessels designed for the Company's fleet will be built in French yards. She comes from the shipyards at Barrow, a place which, twenty years ago, was a desert beach, but to-day is a city of 45,000 souls, thanks to the establishments for naval constructions and to a spinning mill that gives employment to the wives and daughters of the ship carpenters.

One of our engravings represents the vessel at the moment of launching. Below and in front of the stem stands a young lady, the godmother of the new born. The unfastening of a ribbon by her sufficed to give the colossus its liberty by bringing about the fall of an ax that severed the last rope holding back the cradle.

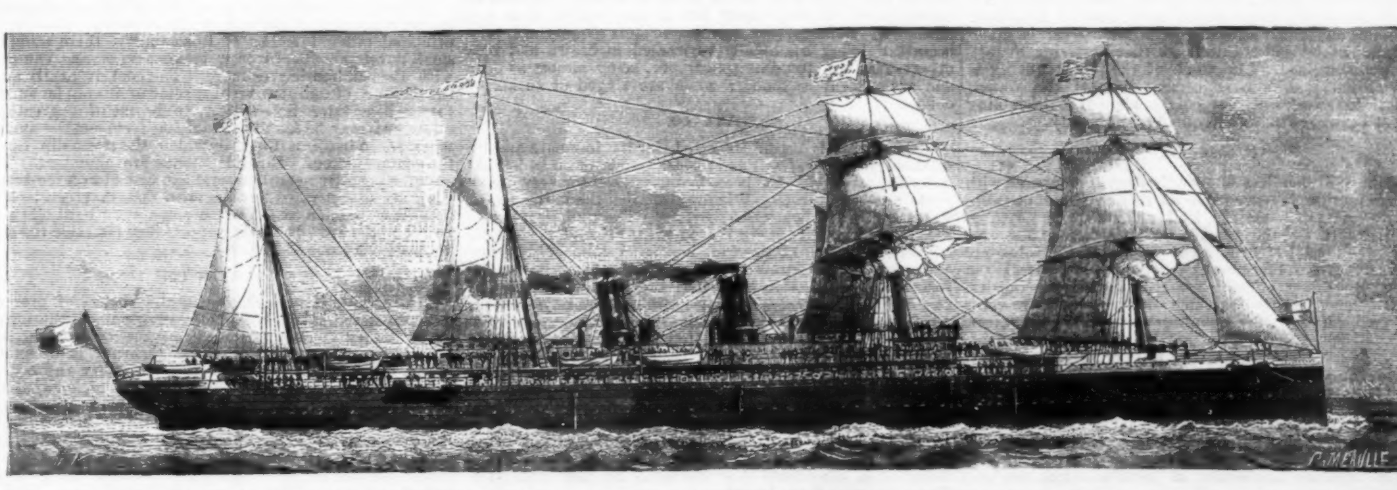


LA NORMANDIE ON THE STOCKS.

A packet boat is a traveling hotel. All the luxury and comfort that reigns in our modern hostelries is found on the Transatlantic steamers, and is carried to the extremest limits in the vessel under consideration. An examination of the section will show at a glance that the deck has been reserved for general service, for the officers' and engineers' quarters, for the smoking saloon, vestibules for passengers of the first and second class, etc. Above the deck, on a level with the roof of the cabins, there is a light bridge to serve as a promenade for the passengers; and, overlooking this, is the bridge for the captain. Orders are given by means of a speaking tube and telegraphic apparatus; but, if need be, the captain can himself steer the vessel by a simple pressure of his finger upon a servo-motor—a steam apparatus which acts upon the rudder.

The passenger cabins are between decks. Passengers of the first class occupy the central part of the ship, contrary to the old arrangement, which located them in the back part of the ship. There the oscillations due to rolling and pitching, and to the revolution of the screw, are less perceptible. The grand dining saloon reaches from larboard to starboard, and measures 15 meters in width by 11 in length and 2·6 in height. It is lighted by port lights set in frames of onyx. Around this saloon are distributed state rooms for 157 passengers, some designed for a single person, others for two, and some for families. Within easy access there is a saloon for ladies, and bathing saloon, and state rooms for servants. Save as to beauty of decoration and of furniture, the arrangements are identical for the smoking saloons and the second class cabins for 68 passengers in the back part of the ship.

Emigrants or third class passengers are installed on the third deck, in a cabin containing 866 berths. The hotel part of the ship is heated in winter by a circulation of steam, and at night the vessel is lighted by electricity. This latter is furnished by two machines of 40 H.P. each. The general service is facilitated by thirteen large arc lamps. In the interior, the saloons and cabins are lighted by 400 Swan incandescent lamps. As well known, it is forbidden aboard passenger ships to keep a light in the state rooms after a certain



THE NEW STEAMSHIP LA NORMANDIE, OF THE FRENCH LINE BETWEEN NEW YORK AND HAVRE.

hour. As there is no danger of fire from electric lamps, passengers will only have to touch a button to relight their lamp and enjoy a light all night.

We are indebted to *L'Illustration* for the accompanying engravings.

SOUTHWESTERN VIRGINIA.

By JAMES HOGG.

COMPARATIVELY few persons are aware that within five hundred miles of New York City there is a large section of country, comprising 13,000 to 14,000 square miles of area, which for the variety and quantity of its minerals makes it in all probability the richest and most interesting mineral country in the world, not surpassed indeed by Saxony in Europe.

This section lies in the southwestern part of Virginia, on the borders of Kentucky, Tennessee, North Carolina, and West Virginia. In it are included seventeen counties of Virginia, viz., Floyd, Montgomery, Pulaski, Giles, Bland, Wythe, Carroll, Grayson, Smyth, Tazewell, Buchanan, Washington, Russell, Dickenson, Scott, Lee, and Wise; and to these may be added Ashe, Alleghany, and Watauga counties in North Carolina, which form an integral part of the same geological formation, and contain the same kinds of minerals. In this section are to be found gold, silver, copper, lead, zinc, nickel, iron, manganese, plumbago, arsenic, antimony, limestone, gypsum, salt, barytes, kaolin, feldspar, soapstone, fire-clay, asbestos, talc, mica, umber, millstone grit, marble, sandstones, granite, syenite, and many of the minor minerals useful in arts and manufactures. In addition to these, the country is heavily timbered from the valleys to the mountain tops with white oak, walnut, maple, tulip tree, basswood, hickory, cherry, chestnut, buckeye, cucumber tree, chestnut and other oaks, locust, dogwood, white pine, black pine, spruce, hemlock, cedar, lash-horn, and other useful woods. Besides containing such mineral and wooded wealth, nearly all of it is a fine agricultural and fruit growing country, especially adapted for the raising of cattle and sheep.

Last autumn we had to supervise a topographical survey, and also to make a mineralogical inspection of a large tract of land in Bland Co.; this occupied us two months, and by observation and information we were enabled to get an insight into the great wealth of this portion of the State of Virginia. The knowledge we obtained by information was mainly through C. R. Boyd, Esq., of Wytheville, a native of the country and a prominent mining engineer, who has published a work on the resources of southwestern Virginia, spending six or seven years in obtaining the necessary knowledge to enable him to do so. In order that a more definite idea may be had of this superabundance of wealth, we will give a concise account of the mineral products of each county. The first county we enter by the Norfolk and Western Railroad is

MONTGOMERY CO.

In the valley of Brush Creek, in this county, gold is found in the gravel beds of the stream and the smaller streams emptying into it. These river washings are found to extend over an area six or eight miles wide. Whether there is any extent of real gold bearing strata is as yet undetermined, although a ledge of gold bearing quartz, from six to twelve feet thick, has been found in one part of the county. Veins of pyrites containing copper and lead and zinc ores have been found, but they are not as yet much developed. Brown iron ore is found in veins, some of which are 100 feet thick, in some places specular and red iron are found, and there are indications of magnetic ores. Large beds of valuable coal are found, accompanied by the usual limestones, sandstones, and slates. Some of this coal is anthracite in character, and some is semi-bituminous. Millstone grit in beds over 200 feet thick is found in some places, and has been used in the flour mills at Richmond with much success and satisfaction.

GILES CO.

All things considered, this is probably the finest county in this section. It combines more veins and deposits of ores, more fine grass and grain lands, noble forests, and beautiful mountain, river, and lake scenery, than can probably be found in an equal area of land anywhere else in the United States. Through it runs the rapid and beautiful New River, which wends its way for more than half its length in this county through lofty and remarkably picturesque cliffs of limestone, its waters ultimately reaching the Ohio through the Great Kanawha River. Owing to its peculiar geological formation and its topographical position in relation to the other counties of this section, it is the one of them through which the four railroads seeking an air line from east to west, and the two from north to south will have to pass; thus, eventually, giving it railroad facilities with the Southern and Northern, the Eastern and Western States.

Like its sister counties, it abounds in iron ores of the finest quality lying in seams of great thickness, and of easy accessibility. Manganese ore of a very rich character is found at some points in large quantities, yielding in one case nearly sixty per cent. of metallic manganese. Copper has only been found in the form of pyrites, and then only in small quantities. Lead and zinc are occasionally found, but the leads are as yet undeveloped, and therefore no proper estimate can be formed as to the quantity. Silver is sometimes found in the lead ores, but whether in paying quantities is undetermined. Limestone of the purest quality is abundant, and hydraulic or cement lime is also found. Marble is found at different points, some of it resembling the finest Tennessee marble in quality and beauty.

PULASKI CO.

This county, although of but small extent as compared with the other counties, is remarkable for its rich mineral wealth, for it abounds in coal, iron, lead, and zinc. One vein of brown iron ore is being worked which is from 200 to over 900 feet wide and 300 feet thick. Some of the veins are entirely free from phosphorus. Specular and fossil red ores are also found. Coal is found in immense quantities, mainly of the anthracite character, although there are veins of soft coal. The veins vary in thickness from 2 to 20 feet, overlying each other. Zinc and lead ores are abundant, and immense smelting works are in operation for their reduction. Silver is found in a stratum of pebbles, underlying the coal measures, but whether in paying quantities has not yet been ascertained. Limestone suitable for burning purposes and for making hydraulic cement is plentiful; some of the ledges yield admirable building stone, and some are beautifully variegated, almost equaling marble in beauty. Beautiful building sandstones of various colors are also abundant.

BLAND CO.

One-half at least of this county is mountainous. Within ten miles of its width it has six or seven ranges of mountains. It lies in the center of the great Appalachian chain of mountains of this section, which includes the Blue Ridge, the Alleghany, and Cumberland ranges. It is also the highest county of this section, the valleys being from 2,500 to 2,800 feet above the sea level, and some of the mountains are 4,400 feet above the same level. The watershed on the easterly side is toward the New River, which, as we have before said, sends its waters into the Ohio; on the westerly side, the watershed forms the head waters of the Halston River, which flows into Tennessee, and with the Clinch River eventually forms the Tennessee River.

It differs somewhat from the other counties in its geological formation, which is very varied. It would occupy too much of our space to go into a detailed description of it, and the same may be said of the other counties. It, however, abounds in iron ores of every class. The brown ores are in immense quantities and of the finest quality, often running into specular and semi-magnetic red ore. Great quantities of fossil red and specular ore are found at various points, especially in some of the mountains. Most of the ores are very pure, and contain a high percentage of metallic iron. Manganese is also found in large quantities, frequently as a binoxide. There is a large vein of very fine bituminous coal, sometimes becoming semi-bituminous, running east and west of Seddon or Bland C. H., as it is now called, along the southern base of Brushy Mountain. It is also found as a separate vein in the Kimberling Valley, where there is a sharp and peculiar uprift of the slate formation through the clays and sandstones of the Kimberling springs. At several points, lead and zinc ores are found, and when the veins are opened up, will probably be found in large quantities. Copper is found, but the indications do not as yet promise it in large quantities. Barytes is now and then found, and the geological formation warrants the belief that salt will eventually be found. The same indications clearly indicate that petroleum ought to be found in the valley of the Kimberling. If this should be so, it is in all probability the only oil basin in Virginia southward or eastward of the Kanawha coal basin. Umber and nickel are also found in this county, and fine building and flagstones are abundant.

TAZEWELL CO.

This county is about 720 square miles in area; within its boundaries are found a superabundance of wealth of mineral, agricultural, and timber lands, combined with very beautiful scenery. It is especially rich in iron ores of high grade, of the various varieties found throughout this section of country. Manganese is distributed throughout the county, and the indications are that it will be found in large quantities. Bituminous coal is very abundant, in large veins of large size and of the finest quality. Some cannel coal is also found. The veins of coal and iron extend in various widths and thickness the whole length of the county, some forty miles. Lead, zinc, and nickel are found in some localities, but they have not been as yet sufficiently developed to determine whether they are in paying quantities. Traces of copper are found in some of the rocks. Barytes exists in large quantities; at one point the vein is fifteen feet thick. Salt and petroleum have been discovered oozing from the surface of lands bordering on the Clinch River, but nothing has been done to ascertain the probable quantity of them. Building stone, both lime and sandstone, is plentiful and of fine quality. Magnesian soapstone is frequent, but marble is not.

WYTHE CO.

In this county are some excellent coal measures, having veins varying from eight inches to six or eight feet in thickness. It includes the bituminous, semi-bituminous, and anthracite varieties; some veins approach cannel coal, and others make most excellent coke. Heavy brown hematite iron ore lies, not in veins, or beds, but in immense belts in the mountain ranges, in some cases being more than 100 feet thick. In one place a vein crops out on the side of a mountain, 400 feet above the creek in the valley below. This vein is four or five miles long on the mountain side, and 200 feet thick; how far it extends into the mountain has not yet been ascertained. Enormous veins of very fine and pure iron ore are found contiguous to the lead and zinc belt. Some of the veins have yielded blooms that were almost chemically pure. Manganiferous iron ores, in beds varying from 10 to 150 feet in thickness, are also abundant. True magnetic iron ore is reported as found in this county, but this needs verifying. Semi magnetic ore is found in beds varying from 9 to 15 feet thick. Fossil or dyestone ore, made up of fossil shells, pebbles, and precipitated iron, is also found in beds of considerable size.

Manganese ores are plentiful, mostly in the form of a black oxide, but sometimes as an almost pure crystalline ore. Lead and zinc are abundant, some of the veins being 18 feet thick. Sometimes the lead and zinc are mixed together in the same vein; in other cases they are separate, and are ultimately stratified in the same rock. Barytes is found in great quantity in some parts of the county, following the lead and zinc veins for miles, and in some cases is found in great masses, and very pure in quality. Kaolin is in large quantities; one bed is two miles long by 50 yards in depth. Gypsum is known to exist in this county, but to what extent is as yet unknown. Some of the marbles in this county are very beautiful, being beautifully variegated in brown and red; others have an onyx-like appearance, being almost as pure and translucent as amber; some are tinged of an amber color.

SMYTH CO.

This county is especially noted for its immense and remarkable deposits of salt and plaster and its iron beds. At Saltville, where salt has been manufactured for very many years, the bed of rock salt is over 175 feet thick, the top of it being 200 feet below the surface. The underlying and the overlying strata are saturated with brine of a strength equivalent to half of the volume of rock salt. This brine appears to be still draining in from the higher geological formations. It is estimated that every hundred acres of this salt basin contains over two million tons of rock salt, yielding a brine of 98 per cent. density. Seventeen miles in length of the north fork of the Holston River show outcrops of salt and plaster.

The gypsum or plaster beds are simply wonderful. It is not definitely known what the extent of these deposits are. In some places where they have been worked, it varies from 80 to nearly 600 feet in thickness. At the smallest depth it would be equal to 90,000 tons per acre; at the greater depth it is equal to 660,000 tons per acre. Where that depth is found, it is considered that 100 acres are thus underlaid. The beds are miles in length.

In iron this county is superabundantly rich. Geologists who have studied the deposits estimate that of the brown ores there are nearly, if not quite, one hundred millions of tons above the water level of the rivers. In addition to these must be added large quantities of specular, fossil, and other red ores, and also magnetic ore, but of the latter the quantity is undetermined, until further investigation is made. There are indications that large quantities of copper, lead, and zinc will be found, but the leads have not as yet been sufficiently examined to give any data for an approximate estimate. Barytes is found in large quantities at one or two points. Gray and purple, and brown variegated marbles, resembling some of the Tennessee marbles, are also found. Kaolin is found in beds of indefinite extent.

WASHINGTON CO.

This county is not nearly as mountainous as the other counties, as the mountains here die away, or disappear so as to form a series of low undulating hills. It is a fine agricultural and timber county, but also abounds in beds of the finest brown, red, magnetic, semi-magnetic, and fossil iron ores. Of copper there are indications, but it is doubtful if it exists in large quantities; the same may be said of zinc, lead, and barytes. Fine variegated marbles exist. Plaster of the finest quality is worked, though but one section of the county holds it and salt in large quantities.

RUSSELL CO.

This, like Tazewell Co., which it adjoins, is a large county, being 34 miles long and 18 miles wide; and like it is noted locally for its fine blue grass lands, large forests of valuable woods, its great coal veins, and marble, although it has not the same great deposits of iron. It has, however, some veins of it, and of manganese ores of high grade. In coal it is very rich. The coal measures in this county occupy an area of about 100 square miles, and so far as they have been examined, the veins overlie each to the tops of the hills. They are of various grades of bituminous and cannel coal. Lead, zinc, and copper have not yet been found in any quantity. The formations of the strata indicate that salt is likely to be found. As in Tazewell Co., the beds of barytes are enormous; sometimes they are 15 feet thick. Limestone for burning and building purposes, and sandstone for building are plentiful. Marbles of various kinds exist in great abundance in the southern part of the county. The scenery is very beautiful.

SCOTT CO.

Differs from its neighboring counties, both in its geological and physical appearance. It is very hilly, and will probably at some future day be largely devoted to the culture of the grape and to sheep raising. Nevertheless, it has an area of about 90 square miles of coal measures, and also has some large and excellent deposits of iron ores. Manganese, lead, and barytes are also found occasionally, but whether they are in any large quantity is undetermined. Salt will no doubt be found under the coal measures. This county is very rich in beautiful marbles, especially of the variegated varieties, such as gray tinted with flesh colored spots, and purple with fossil remains and coral in it.

LEE CO.

This county is 50 miles long by 17 or 18 miles wide. It contains almost unlimited quantities of fossil red iron ores, as well as large deposits of brown ores. The bar iron made from some of these fossil ores is of such high quality that bars of it may be bent double when cold without producing a flaw. It has a coal field of about 75 square miles area, in which are found some of the finest deposits of bituminous, splint, and cannel coal. Pennsylvania experts, from actual trails, pronounce them better than any other known coals for coking and general purposes. None of them so far as tried show a greater percentage of ash than four per cent., and some of them are capable of smelting the iron ore raw. Lead and zinc are not found outcropping, but it is not improbable, from the lay of the strata, that zinc may be found a few hundred feet from the surface in some places. Limestone is abundant and of the finest quality either for fluxing, burning, or building. Kaolin is found in large quantities in the coal measures.

WISE CO.

Is situated in the plateau of the Cumberland mountains. It contains large quantities of fossil red iron ores, probably half the iron ores found in this county being of this character. It is very rich in coal of very fine quality, some of it making very fine coke. Some of the coal is pure enough to use raw in the smelting furnaces. As to quantity, it may be estimated at millions of tons. Lead and zinc are found, but it is very doubtful whether it is in sufficient quantity to pay for the working. Sandstone for building purposes is plentiful.

DICKENSON CO.

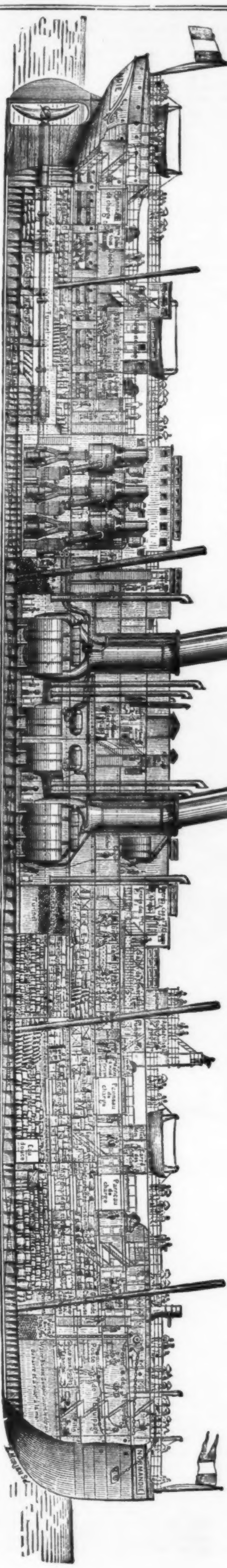
Was only formed out of Wise and Buchanan counties two or three years ago. It is a small county, and its general aspect and resources are like those of Wise Co. It is unsurpassed in its wealth of bituminous and cannel coal.

BUCHANAN CO.

This county is widely different from all the other counties in the character of its soil, which is sandy. Coal is the principal mineral feature of this country, there being but small developments of iron or manganese ores as compared with the neighboring counties. The coal is nearly all of the flaming bituminous variety; some of it may be suitable for smelting raw. Salt is likely to be one of its great products, as it may be found at about 500 feet from the surface, wherever a basin is found in which the strata dip toward the center thereof. Building stones are abundant. They are of a peculiar sandstone, and can be had in large blocks. They are so soft when first quarried that they can be hewn into shape with an ax. They become very hard when exposed to the air. In these respects they resemble the well-known Caen stone of France.

GRAYSON CO.

This county is remarkable for the variety of ores and minerals found in it. Magnetic iron ore of the highest grade is very abundant, and specular ore is found in large quantities. Brown ores are not so plentiful, being mainly found in the gossans or iron caps overlying the beds of iron and copper pyrites, in which gold and nickel are found in fair quantity. Manganese is found as a largely component part of some of the rocks, but is little developed in distinct veins in any quantity. Lead is found in one or more of the copper lodes, and frequently carries with it a considerable amount of silver. It is also found at one point in a sort of trap rock, but it has not been followed up. It is not



LONGITUDINAL SECTION OF THE NEW FRENCH STEAMSHIP LA NORMANDIE.

at all unlikely, judging from the geological formation and the character of the rocks, that gold is to be found in considerable quantities; and if the analogy between these formations and that of Cornwall is correct, tin ought also to be found. Copper is found in quantity, mainly in the form of pyrites, the veins being of great thickness, but the county has not been sufficiently explored to determine whether the copper exists in other forms in any great quantity. There is but one limestone ledge in the county, but it is a valuable one. Feldspar of all the important varieties is very plentiful; particularly the orthoclase or potash variety, which can be obtained yielding fourteen per cent. of potash. This, with the gypsum of some of the other counties, will be of immense value in renovating the worn out lands of the State, the soil of most of it having had nearly all the potash taken out of it under the execrable style of cultivation practiced under the slavery system of labor. Granite of the black, white, porphyritic, and syenitic varieties, together with pure syenite, is found in quantity. Asbestos, and soapstone of very fine quality, especially the latter, are plentiful.

In addition to these leading minerals, the following minor minerals are so often found as to warrant the belief that they may eventually add considerably to the wealth of the county, as they are more or less used in the arts and manufactures: quartz, garnet, tourmaline, beryl, talc, corundum, kyanite, staurolite, hornblende, trap, albite, rutile, actinolite, mica in various forms, chlorite, epidote, oligoclase, orthoclase, labradorite, arsenic, antimony, and probably nickel.

CARROLL CO.

Adjoins Grayson Co., and is the great copper bearing county of this section. The great northern copper lode in this county is one of the richest copper lodes in the world. It sometimes reaches 150 feet in thickness and extends uninterruptedly for 25 miles in length, yielding from 10 to 50 per cent. of copper at the different mines opened. Besides this one, there are other lodes, not of so great extent, but equally rich in metal. In iron this county is also very rich. The miles upon miles of copper veins are overlaid with gossans or iron caps varying in thickness from 12 to 150 feet, yielding at some of the mines about 50 per cent. of pig iron. Specular and magnetic ores are also found, but to what extent is not yet ascertained. Iron pyrites exist in unlimited extent; it is estimated that the vein is 54 miles long by 30 feet thick and of unknown depth. In some cases it contains large quantities of arsenic.

Gold, silver, nickel, and arsenic are indicated in many places, but scarcely any attempts have been made to develop them. The same may be said of mica and asbestos; they are known to exist, but no explorations have been made. Fine granite suitable for building purposes is plentiful, and there are many excellent ledges of soapstone.

FLOYD CO.

Is the next county eastward of Carroll Co., and is southward of Pulaski and Montgomery. It is, like Grayson and Carroll counties, remarkable for the variety of minerals found in it. It contains iron ores of different varieties, copper sometimes containing a considerable amount of arsenic, arsenical pyrites, argentiferous lead, gold, manganese, asbestos, soapstone, plumbago, and limestones.

ASHE, ALLEGHANY, AND WATAUGA COUNTIES IN NORTH CAROLINA.

As we have before stated, these counties, although in an adjoining State, are really a part of the same mineral section, and belong to the same geological formation. We shall therefore consider them as one with the Virginia counties, only separated by political divisions.

Copper is the leading product of these counties. The lode in Ashe Co. is one of the most remarkable and most reliable in the world; about two and a half million pounds of ingot copper having been shipped last year from one mine. Some of the mines yield gold and silver mixed with the copper ore. One mine has yielded one and three-quarter ounces of gold, and eighteen ounces of silver to the ton of ore; and at one mine of purple ore, as high as $2,600 worth of gold was obtained from the ton of ore. Iron ore in Ashe Co. is mostly magnetic, the veins being miles in extent, varying from 5 to 30 feet in thickness, and remarkably pure, containing but a very small percentage of phosphorus and no titanium. Specular ore is also found, but as yet in undetermined quantities. Mica of large size is abundant; kaolin, talc, and very pure feldspars are plentiful. Asbestos is also found in quantity and of fine quality. It contains also many of the minor minerals.

MINERAL SPRINGS.

As might be expected from its geological formation and the abundance and variety of its minerals, this whole country abounds in mineral springs of various kinds, many of which are noted for their high curative powers, fully equal to any of the much extolled mineral springs in Europe. In some cases springs of different character issue from the same rocks within six or eight feet of each other. Their proved efficacy in so many kinds of diseases, the mountain air, and the beauty of the scenery combined make a combination of circumstances which cannot fail to be productive of the highest value to the invalid, especially where tonics and restfulness of mind and body are a necessity in the treatment.

SCENERY.

The whole section is full of beautiful scenery, delightful views being attainable from almost any point. In some of the counties it is highly picturesque and romantic. In Montgomery Co. are the Styles Falls, of 50 feet; the Puncheon Run Falls, a cascade of 1,000 feet, the fall being 350 feet high at one point; and the Dudley Falls, of 90 feet. In Wythe Co., at Wytheville, are the great white chimney rocks on top of the Lick Mountain, composed of white Potsdam sandstone. In the limestone formation are many caves, some of which in extent and beauty would equal the noted Luray Cave.

In Smyth Co., at the junction of its boundary with those of Grayson and Washington counties, is the White Top Mountain, on the top of which is a grassy plateau, about one hundred acres in extent, from which, at 5,500 feet above the sea, may be had a bird's eye view of the three counties, with their lower ranges of mountains, their streams, valleys, towns, and fine grazing farms dotted with great herds of cattle. Saltville, in this county, is remarkable for its lovely scenery. It is situated in a basin or valley amidst the mountains, and is a perfect gem of loveliness. On the top of Salt Pond Mountain is a lovely lake, about three-quarters of a mile in length, but not quite so wide. It is only about one hundred years old, and it is supposed that the early settlers, salting their cattle at the salt springs in this depression on the top of the mountain, the trampling of the cattle closed the vents, causing the depression to fill with water, and become the beautiful lake that it now is. Some of the old trees can yet be seen at the bottom of the lake. From the top of Angel's Rest, 2,000 feet above the plain below, very beautiful views are obtained, in which the New River, wending its course through the county, is a prominent feature. At various points on this river, the limestone cliffs, rising from 300 to 500 feet above the water, and stained with red, brown, drab, black, and other shades, are wondrously picturesque. The mountain gorges also are full of falls, and cascades of great beauty.

In Tazewell Co. is a very remarkable mountain known as Burke's Garden. It is about 3 200 feet high, surrounded by other mountains, some of which are 1,500 feet higher. The top of it is about eight miles long, and about four and a half miles wide. It is deeply depressed, and probably in some past age was a lake, which at last found an outlet for its waters at one point of its shores, and poured them into the valley below, this outlet still existing as the only point of drainage, in the shape of a beautiful trout stream. The bottom of this lake now forms some of the very finest lands for agricultural purposes. Dial Rock is another mountain affording beautiful views of the valleys below; from it also the views of the different mountain ranges suggest the idea of a sea of mountains. Paint Lick Mountain is so called because its high cliffs are covered with paintings made by the aboriginal Indians.

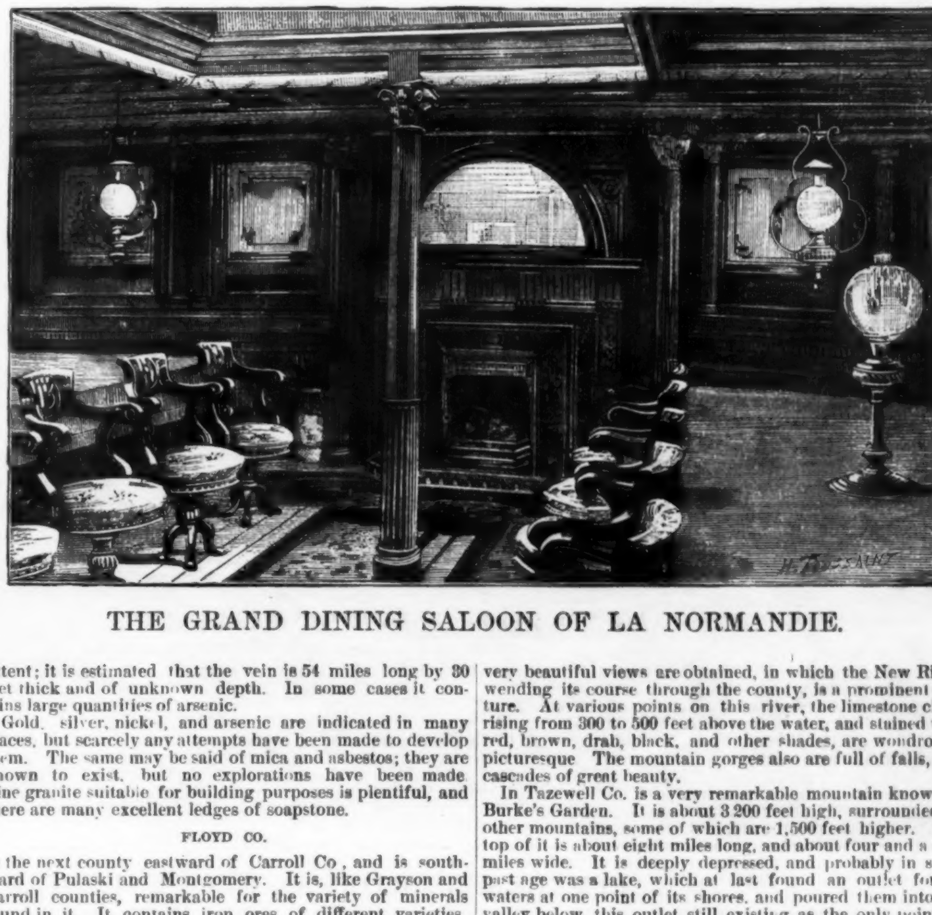
In Scott County there is a curious and beautiful natural tunnel on Stock Creek, 1,400 feet above the level of the sea. The approach to it, with its high, weather stained cliffs is very picturesque.

In Lee County, are some extraordinary caves, of great extent and beauty; one of them is said to be larger in extent than the Mammoth Cave in Kentucky, and to surpass the Luray Cave in grandeur and beauty. The Mound Builders once lived in this county, for many evidences of their existence are found in the shape of mounds containing human remains and ornaments.

In Buchanan County the scenery is sometimes very fine. The principal point of interest is a place known as "The Towers," a series of cliffs, rising some 600 feet above the waters of Russell's Fork, a branch of the Sandy River.

In Floyd County, the falls of the Roanoke are very picturesque; the Beatrice Fall is about 90 feet high and almost perpendicular; the Prince Imperial Fall is smaller in quantity but nearly 200 feet high, both falling into the same pool or basin in the river below.

In every one of the counties, bits of scenery, sublime, picturesque, or softly beautiful, may be found on every hand, and would afford a rich field for our landscape painters.



THE GRAND DINING SALOON OF LA NORMANDIE.

AGRICULTURE, ETC.

The main character of the agriculture of this section is now, and probably always will be, stock raising. At the northerly base of the range of the Big Walker Mountain, the blue grass region commences, which gives sustenance to great herds of cattle; many sheep are also raised. The land is nearly all of excellent quality, and well adapted to the raising of corn, wheat, barley, oats, flax, etc. Tobacco is also raised in considerable quantity in some of the counties. The topography of the country, with its long and frequent ranges of high mountains, has compelled the farmers to go into stock ranging, for they could not get any of their products to market, unless it could be carried off on its own feet. Of the cereals they only raise enough for themselves and their stock.

Fruits do well, especially apples and grapes. When the means of transportation are better than they now are, fruit raising will become a large industry. Bee culture is largely attended to, and with much success. Fish culture is receiving a great deal of attention, and so far has been very successful. The beautiful clear streams are well adapted for trout, bass, carp, and other fish.

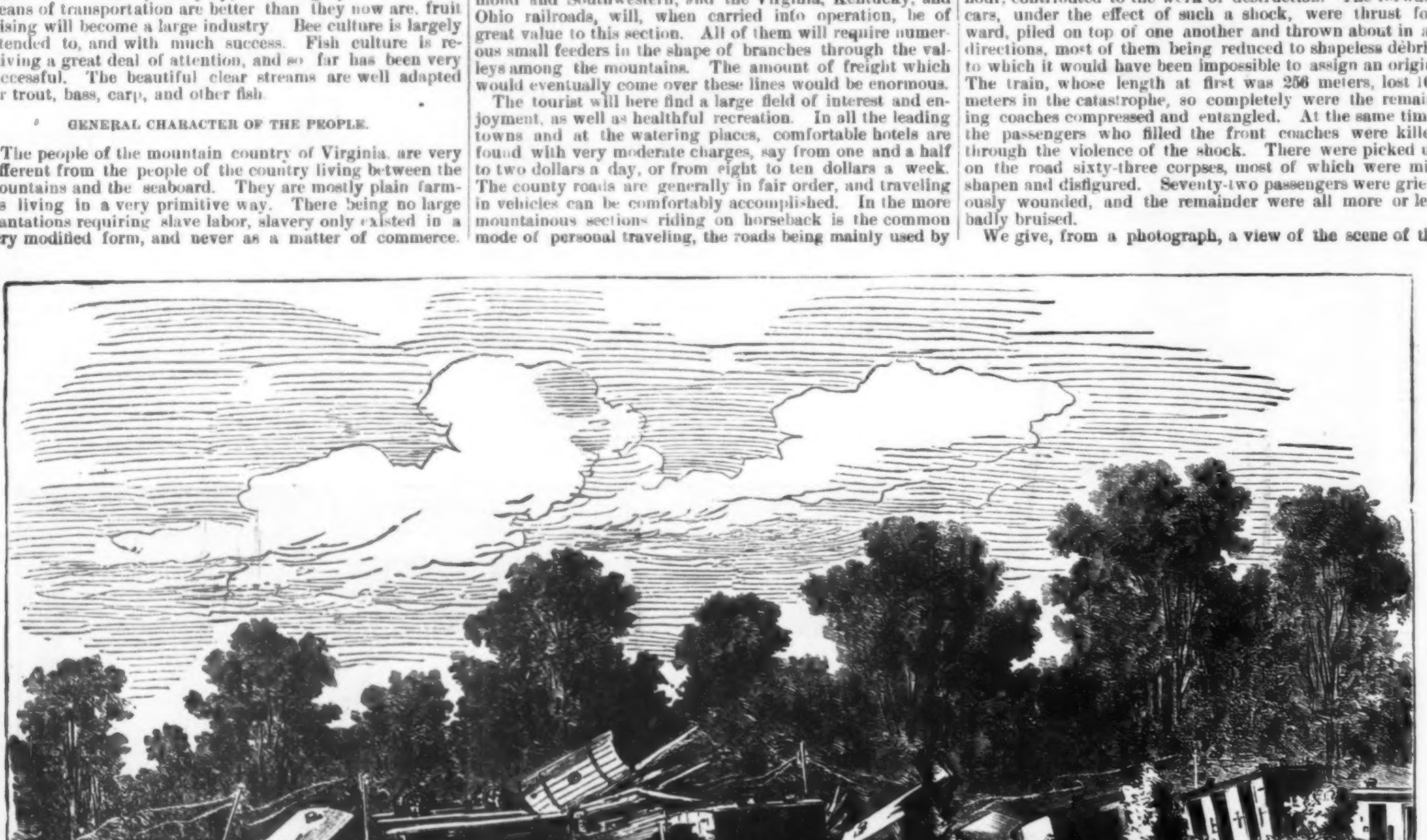
GENERAL CHARACTER OF THE PEOPLE.

The people of the mountain country of Virginia, are very different from the people of the country living between the mountains and the seaboard. They are mostly plain farmers living in a very primitive way. There being no large plantations requiring slave labor, slavery only existed in a very modified form, and never as a matter of commerce. They are kind, hospitable, and social with strangers, provided they do not put on airs of superiority. Living within themselves, raising their own flax and wool, preparing, spinning, and weaving it, and making it into garments, they are naturally independant. The income of railroads among them is, however, gradually breaking up this mode of living, and they are finding out that it is better to make an exchange of commodities and to buy manufactured goods. This is a great relief to their women folk, who, under the primitive simplicity rule, had and have a hard, slavish time of it. If any of our readers wish to realize what is involved in the too often eulogized primitive simplicity of our forefathers, they have only to visit this section to be thoroughly disgusted with it. Living in log cabins, two or three double beds in a room, with lackings in the way of what we consider absolutely necessary for decency and comfort, it would be thought the people would be immoral, coarse of speech, and rude in manners. To the contrary, they are eminently a moral and religious people, modest in speech, polite in manners, intelligent, of fair education, and well acquainted with what is going on in what is to them an outside world, being great newspaper readers. Accustomed to the varnished politeness and hollow-heartedness of our city life, we found it perfectly refreshing to be among a people of sincerity, open-heartedness, and honest dealing.

Nothern capital is quietly flowing into the country on account of its great mineral wealth, and numerous extensive smelting works, forges, etc., are in operation, bringing money into circulation among them. They fully realize that their interests are tied up with other sections of the United States, and gladly welcome any stranger who comes among them to look at their unlimited mineral and other resources, and will do anything in reason to induce him to settle among them and to aid in the development of these riches. If the leading men of Virginia were less of politicians and more of statesmen, their State would in twenty-five years be the richest in the United States. As one plain spoken man of this section explained it to us, one-half of the leading men want to hold office, and the other half want to open store to sell whiskey to the first half, instead of uniting and making common cause in bringing their great natural wealth to the notice of the rest of the world.

Their great need at present is the means of transportation. The Norfolk and Western Railroad is at present the main outlet for their products. The Chesapeake and Ohio, and the Shenandoah Valley railroad companies are gradually working their way in this direction. The proposed Richmond and Southwestern, and the Virginia, Kentucky, and Ohio railroads, will, when carried into operation, be of great value to this section. All of them will require numerous small feeders in the shape of branches through the valleys among the mountains. The amount of freight which would eventually come over these lines would be enormous.

The tourist will here find a large field of interest and enjoyment, as well as healthful recreation. In all the leading towns and at the watering places, comfortable hotels are found with very moderate charges, say from one and a half to two dollars a day, or from eight to ten dollars a week. The county roads are generally in fair order, and traveling in vehicles can be comfortably accomplished. In the more mountainous sections riding on horseback is the common mode of personal traveling, the roads being mainly used by the teams in transporting goods and produce. We found traveling on horseback the most agreeable, as we were enabled to make short cuts from one point to the other by means of the bridle paths over the mountains, which also enabled us to get many a grand and beautiful view which we should otherwise have lost. There are four routes by which this section can be reached. From this city to Richmond and thence to Burkesville on the Norfolk and Western Railroad; from Baltimore to Norfolk, by the Bay Line of steamers; by the Virginia Midland road from Washington to Lynchburg, which is the most direct route; and by the Old Dominion Line of steamers to Norfolk. We especially recommend this latter route to those who are not troubled with seasickness. Their steamers have most luxurious accommodations, tables equal to those of the best city hotels, and a discipline among the crew equal to that of a man-of-war.



REMARKABLE RAILWAY ACCIDENT, NEAR FRIBOURG.

DERAILMENT OF A RAILWAY TRAIN AT HUGSTETTEN, NEAR FRIBOURG.

ON Sunday, the 3d of September, 1882, a terrible railroad catastrophe occurred at the Hugstetten station, near Fribourg, while a pleasure train consisting of twenty-six coaches, carrying 1,200 passengers, which had started from the last named place in the morning, was returning in the evening in the direction of Colmar. The train was hauled by a freight locomotive, but was running, nevertheless, with great speed, since it was descending somewhat steep grades of 1 to 86 and of 1 to 111, extending over a length of 5 to 6 kilometers. On approaching the Hugstetten station the grade becomes less steep, being only 1 to 146, but the ground is very marshy, and the road bed at the time had been channeled by continual rains. It was at this point that the derailment occurred at half past eight o'clock in the evening, the rails disappearing from under the wheels of the engine, and the latter, running at a terrific rate of speed, and pushed by the rear of the train, rolling for about 200 meters on the roadway, then deviating to the right and plunging into the ground at a distance of 40 meters from the track.

Then occurred a fearful mêlée that it is impossible to give any idea of. The rear of the train, whose velocity was moderated by nothing, rushed with terrific force against the forward part, which formed an obstacle to it on the track, and the entire thrust of this enormous mass, which weighed no less than 300,000 kilogrammes, and which was running at a speed greater, perhaps, than 60 kilometers per hour, contributed to the work of destruction. The forward cars, under the effect of such a shock, were thrust forward, piled on top of one another and thrown about in all directions, most of them being reduced to shapeless débris, to which it would have been impossible to assign an origin. The train, whose length at first was 256 meters, lost 100 meters in the catastrophe, so completely were the remaining coaches compressed and entangled. At the same time, the passengers who filled the front coaches were killed through the violence of the shock. There were picked up on the road sixty-three corpses, most of which were misshapen and disfigured. Seventy-two passengers were grievously wounded, and the remainder were all more or less badly bruised.

We give, from a photograph, a view of the scene of the accident, in which will be recognized the locomotive and its tender, both but slightly damaged, so to speak, since they were quickly thrown outside of the road and did not have to support the shock from the rear of the train. The engine and tender were carried without damage to a distance of 40 meters from the track. This circumstance shows that the speed must have been great to have enabled the engine to run to such a distance over so marshy a ground. The baggage car, which comes next, and is marked No. 1, is also thrown to the left and turned end for end, while coach No. 2 is thrown to the right and overturned. Coach No. 3, on the contrary, has come up behind the baggage car, and has been followed by five others (Nos. 4 to 8), all broken, but still coupled together. The eight that follow (Nos. 9 to 16) are completely broken up and absolutely shapeless, and are so entangled and piled up on one another as to make it impossible to distinguish them or even to ascertain what was formerly the role of the fragments that remain of them. These are the coaches, evidently, that have undergone the whole shock from the rear of the train, the first having already been thrown outside of the track.

The three cars which come next (Nos. 17 to 19) are quite badly damaged; then five others (Nos. 20 to 24) are simply thrown off the track, and finally, the four last are, so to speak, in no wise harmed. As for the track, the rail to the left at 170 meters from the engine was bent; at 140 meters another much more pronounced bend was found; at 118 meters, the rail to the left was thrown to the side, and at 130 meters was turned up side down; and finally, starting from 80 meters, the track was completely torn up on both sides.

According to the conclusions at which Mr. Streckert has arrived, the derailment must be attributed to the bad state of the track, due to its having been washed by the rain; but it must be taken into consideration also that the engine was going at an exaggerated speed, which was accompanied by enormous oscillations that resulted in the accident, the rails having necessarily disappeared during an ascending movement of the fore wheels. Finally, the train thus running down a somewhat heavy grade, did not have sufficient means of stoppage; for only seven out of the twenty six coaches were provided with brakes, and only six of these were manned by brakemen. The action of the brakes thus limited was sufficient to prevent the enormous mass of the train being drawn on heavy grades, but not to stop it entirely in case of accident.

It is proper to add that hand brakes, under like circumstances, where a moment's hesitation may compromise the safety of the train, are almost always inefficient. The brakeman cannot at once take in the situation, and, while he is querying, he loses, without acting, valuable time, in which he would perhaps have been able to prevent the catastrophe.

The engineman was doubtless aware of the derailment at a distance of 250 meters, the spot at which were found the first traces of the wheels on the rails, but he has not whistled down brakes at the same instant, and his order has been obeyed only after the lapse of the few seconds during which the rear of the train crashed against the head.

It seems, then, that with a continuous brake running the whole length of the train, each of the cars of which would have been provided with its brakes, this catastrophe might have been in a great measure averted. The engine, after the first instant of the derailment, ran, in fact, about 250 meters. Now, the majority of continuous brakes in use are capable of stopping a train going at a speed of over 60 kilometers per hour within much shorter limits.

As the partisans of automatic brakes have taken occasion to remark, the Hugstetten accident furnishes a very grave argument in favor of this type of apparatus; for it would, in this case, doubtless have been impossible to actuate a non-automatic brake in time enough to stop the rear of the train before the shock, while an automatic apparatus would have entered into action of itself, without the intervention of the engineman, as soon as the conduits became damaged. It may even be asserted that a non-automatic brake might have aggravated the accident, if the engineman had actuated it only when the conduits were already broken; for, under such circumstances, the head of the train alone would have been submitted to the action of the brakes, and would have stopped much quicker, while the rear, uninfluenced by the brakes through the breakage of the conduits, would have made an onset against the forward coaches.

Taken altogether, this may be said to have been one of the rarest of accidents in the history of railroading.—*La Nature.*

HYDRAULIC MACHINERY.*

By PROFESSOR PERRY.

HYDRAULIC machines are very wonderful to people who observe their action for the first time. Here is a model of the common hydraulic press, and with this little model a laborer, without any other help, can raise a load of 100 tons, which is the weight of a long railway train. If you go to any large docks, you will see how, by the manipulation of a few handles, a boy can lift heavy weights rapidly from ships, placing them on the dock. Visit any large steel works, and you will see great armor plates and great Bessemer converters and their appliances passed about nearly as readily as small objects are moved by a village blacksmith or a brass-moulder. Visit the Victoria Docks, and you will see the largest ships raised out of the water on a floating gridiron, and towed off for repairs. Visit the River Weaver, in Cheshire, and you will see sections of a canal rising and falling with canal boats. Instead of bringing a boiler or iron girder near a riveting machine, Mr. Tweddell takes a little riveting machine to the boiler or girder, and works it through small flexible pipes from a distance. Think of centrifugal pumps which discharge 100,000 gallons per minute, or those of smaller size, which, worked by their little steam engines, would keep the leakiest ship afloat; of those insignificant little machines called turbines, which make up in speed for their small size, and whose development is really in the future when electricity shall have become a handmaid of industry.

The wonder with which we look on hydraulic operations for the first time soon passes away, but I want to impress upon you the fact that this does not imply a knowledge by the general public of the nature of the action of water in these cases.

With few exceptions, the general public are utterly ignorant of the properties of electricity. People say that, when electricity is supplied to every house, as water is at present, everybody will get a knowledge of its properties. This reasoning is very fallacious. From our early swimming days, we have had much to do with water. We all take sea and river voyages and are tossed about by water. We wash in it and drink it. It is supplied to our houses in large or small quantities. In spite of all this there is a wonderful ignorance everywhere as to the properties of water.

The internal construction of an hydraulic press is shown in Fig. 1. The usual appearance of such a press when used for warehouse work is shown in Fig. 18. Three men press, each with a force, say, of 60 lb., on the end of this lever, A. The mechanical advantage of the lever is about 20, and hence this plunger, C, is pressed downward with a force of 3,600 lb.

Just consider for an instant what is the condition of things before the laborers act on the lever. Here is a ram, B, which carries a heavy weight, the weight to be lifted. Observe that this ram is wanting to fall, but it can only fall into the vessel, D. Now, the space between the vessel, or press, and the ram, and all the space in these tubes, E, is filled with water, which has no means of getting away. It might get away by this little valve, F, but that the valve can only open inward, and the more the water tries to escape, the more it really closes the valve, just as a closely packed crowd in a panic keeps an inward opening door closed, by which they might otherwise escape from a theater. There is no escape for the water anywhere on the pump side, and there is just as little on the other side, for you see that the water, if it escapes into the space, N, finds that it has still to get past the leather, which is, however, so placed and shaped that the greater the water pressure the tighter the leather fits the ram. Fig. 6 is a specimen of such a leather collar.

There is, then, no escape for the water, and when this is the case, no matter what weight is placed on the top of the ram, it cannot fall. The falling of the ram would mean some escape for this water; but as there is no escape for the water, the ram will fall no more than if it were supported on some quite rigid material.

I have been supposing here that a certain quantity of water will absolutely refuse to occupy a smaller space, but this a not quite correct. You know that if it were air that filled this space, D, instead of water, and there were no escape for it, the ram would fall when a greater weight was placed on it; for although the air cannot escape, it is contented to occupy a smaller bulk. I have been supposing that this does not occur in water, and that water will refuse to go into a smaller space, whatever the pressure. This was an old notion which people deduced from the famous Florentine experiment. A hollow globe of gold was quite filled with water, and was hermetically sealed. It was then beaten to diminish its cubic contents, and the result was that drops of water made their appearance on the surface, having oozed out through the pores in the gold rather than submit to the lessening of the total bulk.

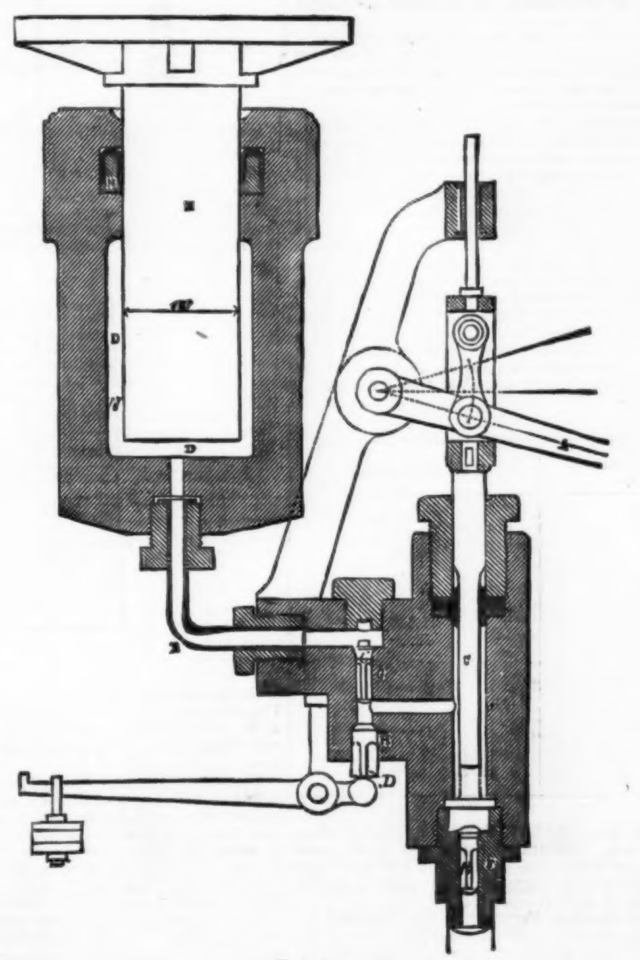


FIG. 1.

Mr. Roe tells me that a friend of his, in illustrating lectures given to the Royal Engineers at Chatham, pressed the water inside a cast-iron shell so much that it came through the pores of the iron, and appeared as a fine spray or mist on the outside, and soon afterward the shell burst, or rather fell gently in pieces. But, with a piezometer, it is easy to show that water and all other substances will submit to a diminution of their bulk when subjected to pressure; and we find that this diminution for water is one twenty-thousandth of its total bulk for a change of pressure of one atmosphere, or one seventieth of its volume for a pressure such as we find in hydraulic presses. Now this diminution in bulk is far too insignificant to be of much practical importance in hydraulic machines, and we may take it for granted that whatever weight be placed on this ram, it will not perceptibly fall, because the water refuses to become smaller in bulk, and because it cannot escape anywhere.

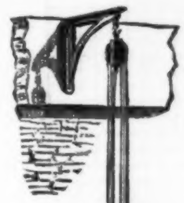


FIG. 2.

You understand that it tries to get away; it is trying to burst this thick cast-iron press; it is trying to burst these pipes and the pump. Before it will burst the pump, it will open this safety valve, H, and escape; but we can assume for the present that the pressure never reaches the bursting pressure of the arrangement.

Now the laborer acts on his lever, forcing down the plunger. The water here is just like the water in the press; it tries to escape, it tries to burst this pump barrel, it resists the motion of the plunger. It tries to escape through the valves, F, G, and H, and it will open this valve, G, and pass through, if the laborer acts sufficiently on his lever; but if it passes through, the ram must rise, however great the weight may be above it. The question is, then, what force on this plunger, C, is sufficiently great to cause motion, that is, to cause the water to pass through the valve, G; that is, to make the ram rise?

There is a law which is found to be true in all machines—the law of work. The work done to any machine is exactly equal to the work done by the machine, unless it is stored in the machine or wasted. If a weight of 10 lb. falls slowly six feet, acting on a machine, then the machine has been given sixty foot-pounds of mechanical energy, and it will give this out again. The machine can lift 6 lb. ten feet, or 60 lb. one foot, or 120 lb. half a foot. It can do this if there is no friction; it cannot do more than this; it, in all practical cases, does less than this.

A machine can store energy by the coiling of springs, the lifting of weighty parts of its mechanism, and in other ways, and its main method of wasting is by friction at rubbing surfaces, which converts mechanical energy into heat. We know, then, that the work given to this machine by the plunger, C, is equal to the work done in lifting the ram, minus the work lost in friction, if we are quite sure that the

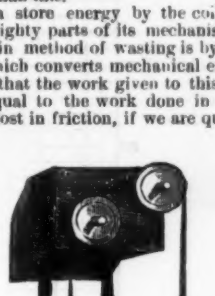


FIG. 3.

water is just in the same average state of compression all the time. For you must regard the squeezing of the water and the elastic yielding of every part of the apparatus as you look upon the coiling of a spring—that is, as a store although but a small store, of energy.

This hydraulic press, then, may be looked upon as we look at this block and tackle (Fig. 2), or the machine inside this wooden case (Fig. 3); a machine that will give out undiminished, except by friction, all the energy we give to it.

I cannot easily obtain quantitative results before you with this hydraulic press. But let me take this very simple machine (Fig. 3) to illustrate my meaning.

You see that when the weight A falls, the weight B is

* Abstract of a lecture before the Society of Arts, London, 1882.

lifted. In considering such a machine, we first find out how many feet B will fall when A rises, say one foot. Now I find that B falls 20 feet when A rises one foot. Suppose the weight of B to be 6 lb., in falling 20 ft. it gives to the machine 20 × 6, or 120 foot pounds of energy, and if there is no friction in the machine, this same amount of energy is devoted to the lifting of A. Now, if A is 120 lb., then in rising one foot, just 120 foot pounds of energy will be consumed. We see, then, that if there is no friction in this machine, 6 lb. at B ought to be just able to support 120 lb. at A, the weights being inversely proportional to the speed with which they fall and rise. B falls twenty times as fast as A rises, and consequently B will balance twenty times its weight at A.

This machine is inside a box and you know nothing of how the falling of A causes B to rise; but when you are told that there is no coiling of springs inside, and no friction, you feel sure, from all your experience of nature and machinery, that the above calculation is correct.

If we opened up this box, we might find out how it is that when B falls twenty feet A only rises one foot. The connection may be through a million wheels and levers or only one axle; outside measurement is enough for us without an inside examination. Suppose now that very careful measurements have been made on this hydraulic press when it is in action, and it is found that the end of the lever A falls 2,000 times as fast as the weight on the ram is lifted. You know that if there is no friction, a weight of 1 lb. at A will balance a weight of 2,000 lb. at B, and hence a weight of 180 lb. at A will balance a weight of 360,000 lb., or nearly 170 tons, at B. This you can tell without examining the inside of the machine. And if there is friction, what you do is this: You place a weight of 10 lb. at A, and find what great weight at B is just lifted slowly. You repeat this process with 20 lb. at A, and then 30 lb. at A, and so on, and obtain such a table as the following:

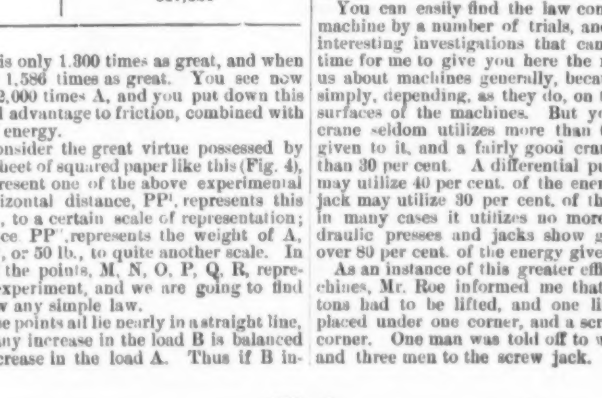
Weight, A, which causes a slow motion.	B, the weight on ram.
10 lb.	12,976 lb.
20	28,916
30	44,996
..	....
..	....
..	....
50	77,032
..	....
..	....
..	....
100	156,853
..	....
..	....
..	....
200	317,121

When A is 10 lb., B is only 1,300 times as great, and when A is 200 lb., B is only 1,586 times as great. You see now that B is by no means 2,000 times A, and you put down this loss of your mechanical advantage to friction, combined with a small useless store of energy.

Here we come to consider the great virtue possessed by squared paper. Get a sheet of squared paper like this (Fig. 4), and let a point, P, represent one of the above experimental results. Thus the horizontal distance, PP', represents this weight of B, 77,000 lb., to a certain scale of representation; and the vertical distance PP'', represents the weight of A, which just overcame it, or 50 lb., to quite another scale. In the same way each of the points, M, N, O, P, Q, R, represents the result of an experiment, and we are going to find out whether they follow any simple law.

You observe that these points all lie nearly in a straight line, and this tells us that any increase in the load B is balanced by a proportionate increase in the load A. Thus if B increases by 16,000 lb., A increases 10 lb., so that the increase of B is 1,600 times the increase of A. The line also tells me that when there is no load on the ram, a load of 1·875 lb. at A is necessary to cause a slow motion of the machine.

Fig. 4



In fact, I have carefully considered this sheet, and find that the load necessary at A is a force of 1·875 lb., together with the fraction one sixteen hundredths of whatever load is placed on P. This is a very different matter from the mechanical advantage that we expected to obtain, when we considered that there was no friction. In fact, we may take it that about 20 per cent. of the energy given by the laborers to the handle is wasted in friction.

Different experiments give different results as to the loss in friction. Rankine's results were about 20 per cent. of loss; but Mr. Hick, of Bolton, in 1867, found results which were less than one-tenth of Rankine's. It is, then, very probable that there is usually much less than 20 per cent. of loss in hand-worked hydraulic presses. The law that I have here given you for a hydraulic press is exactly of the same kind as the law you get for any machine. In all simple and complicated machines, when one force, A, is just able to overcome another, B, you will find by experiment that A is equal to some number of pounds together with a certain fraction of B. You will also find that the velocity ratio is in every case quite misleading.

Thus in the note books of my students I found results of experiments on a crane, which are given out in the following table:

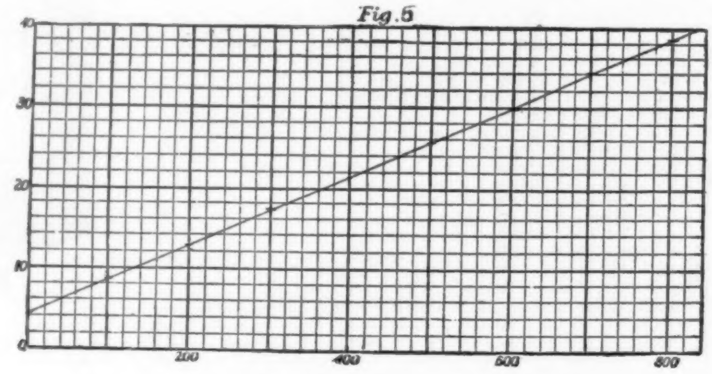
B, weight lifted slowly.	A, weight acting on string round grooved wheel, instead of the ordinary handle.
100 lb.	8·5 lb
200	12·8
300	17·0
400	21·4
500	25·6
600	29·9
700	34·2
800	38·5

Plotting these numbers, as shown in Fig. 5, they obtained the law—

$$A = 4·21 + 0·0429\ B.$$

But they found that A fell 40 times more rapidly than B rose, and hence, if there were no friction, A ought to lift a weight forty times greater than itself. Thus the weight of 800 lb. ought only to need 20 lb. to lift it; but in the actual case it needs 38·5 lb., or nearly twice as much. The difference, 18·5 lb., is the increase of the force required at A which is necessary to overcome friction. In fact, only 52 per cent. of the labor given to the machine is utilized.

Fig. 5



You can easily find the law connecting A and B for any machine by a number of trials, and it is one of the most interesting investigations that can be made. There is not time for me to give you here the results that are known to us about machines generally, because they cannot be given simply, depending, as they do, on the state of the rubbing surfaces of the machines. But you may safely say that a crane seldom utilizes more than 60 per cent. of the work given to it, and a fairly good crane may even utilize less than 30 per cent. A differential pulley block, well greased, may utilize 40 per cent. of the energy given to it. A screw jack may utilize 30 per cent. of the energy given to it, but in many cases it utilizes no more than 15 per cent. Hydraulic presses and jacks show generally a utilization of over 80 per cent. of the energy given up by the laborer.

As an instance of this greater efficiency of hydraulic machines, Mr. Roe informed me that a platform weighing 12 tons had to be lifted, and one little hydraulic jack was placed under one corner, and a screw jack under the other corner. One man was told off to work the hydraulic jack, and three men to the screw jack. Our friend with the hydraulic jack, with one hand in his pocket, would pump a few strokes, and then quietly stand by for an interval, whereas the three men were hard at work with the screw jack all the time. He was able, in one-fourth the time, to do easily as much useful work as the three men were doing, working their hardest.

I find on this card that, three hundred years ago, Fontana raised an obelisk at Rome with 40 capstans, worked by 960 men and 75 horses. Forty-six years ago Le Bas raised the Luxor obelisk at Paris with 10 capstans, worked by 480 men. Four years ago, Mr. Dixon raised Cleopatra's Needle in London with four hydraulic jacks, in every respect like the one which you see before you, worked each by one man.

I understand that the heaviest gun which has been manipulated by ordinary gearing is one of 18 tons. All larger guns are worked by hydraulic machinery, and on the system about which I mean to speak in my fourth lecture, there seems no reason for doubting that there is no limit whatsoever to the size of guns which can be rapidly manipulated by hydraulic machinery. Let us hope that some social frictional resistance will come in, to replace the absence of material friction in such cases.

My students in Japan used to employ a little hydraulic press, just of this size, to crush bricks, stones, and wood, and it was roughly assumed that the friction at the glands was insignificant. Of course, we only made this assumption when we wanted rapidly to get a rough idea of the relative strengths of materials to resist crushing. Still it was a sort of thing that we should not have been able to do with a screw jack.

Let us now consider why it is that hydraulic machines have so much greater an efficiency than ordinary machines. In the hydraulic press, as in any other machine, the mechanical advantage, leaving friction out of account, simply depends on the relative velocities of the plunger and the ram.

You are all well aware of how it is that wheels, screws, levers, and belts diminish or increase speed. How does the hydraulic press effect this object?

Suppose that this plunger, C, is one square inch in section, and that one inch more of its length is forced into the pump; evidently the metal takes up the place of an equal bulk of water, or one cubic inch. For you know that one inch of material, one square inch in section, contains one cubic inch. This cubic inch of space is now occupied by metal, and it used to be occupied by water, and the water has found one cubic inch of room for itself somewhere else. As we suppose no greater compression of the water, and no yielding of the sides of the press, it is evident that one cubic inch of the ram must leave the press to give the water the space it must have. Now, if the ram is 100 square inches in section, then one one-hundredth of an inch of its length contains one cubic inch in volume. If the ram lifts through the distance one one-hundredth of an inch, it will, therefore, leave one cubic inch of room behind it.

We are not concerned with the shapes of the ends of the plunger and ram; we know that if one more inch of the plunger enters the water, one one hundredth of an inch of the ram must leave the water; that is, the relative speeds of plunger and ram are as one inch to one one-hundredth of an inch, or as one hundred to one. The plunger must move one hundred times as quickly as the ram, and by the law of work, if there was no friction, a force of one pound on the plunger would balance a force of 100 pounds on the ram. We know the mechanical advantage, then, if there were no friction, in the portion of this machine from plunger to ram, if we know how many times greater is the area of the ram than the area of the plunger.

So much, then, for the mechanical advantage if there were no friction.

And now, where does friction occur in the hydraulic press? It occurs at

1. The rubbing surface at the fulcrum of the lever. This is the friction of solids.

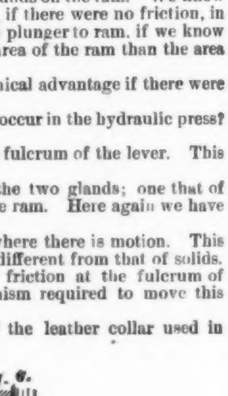
2. The rubbing surfaces of the two glands; one that of the plunger, the other that of the ram. Here again we have friction, as if between solids.

3. Everywhere in the water where there is motion. This is fluid friction, which is quite different from that of solids.

You know the nature of the friction at the fulcrum of the lever, or any other mechanism required to move this plunger.

Here is a specimen (Fig. 6) of the leather collar used in presses. It is made from the best leather, softened in hot water, and pressed between cast-iron moulds to its present shape, the pressure gradually increasing. It is then left for several days under pressure in the mould. The water gets behind this leather and presses it tightly against the ram. The friction seems mainly to occur at the part, A, and increases as the pressure of the water increases. Mr. Hick found that there does not seem to be much friction at the portion between A and B, and the efficiency of the press is but little altered by making A B greater or less. It is, however, asserted by some makers of presses, that the distance, A B, is of importance; but I rather think that this is on account of deterioration. The part, B A, is constantly being in states of tension and compression, and is liable to crack. When the leather deteriorates, much time is wasted in renewing it.

Fig. 6.



Hemp packing is invariably used instead of the leather collar at low pressures; some manufacturers never use hemp or cotton when the water has a greater pressure than 700 lb. per square inch, but Mr. Tweddell and others use hemp to 2,000 lb. per square inch.

Our subject is too large to allow me to enter into many details as to the advantages and disadvantages of leather, india-rubber, and gutta percha for packing purposes. There is a great divergence of opinion, and I believe that much of the evidence against one or another material is based on the bad preparation of the materials against which the evidence is given.

In Figs. 11, 12, and 13, you will see the form of India-rubber cup used in hydraulic jacks and bears. It is moulded in this form, and is fastened to the end of this ram by means of a screwed bolt and metal washer, as shown in the figure. The water pressure keeps it tight against the cylinder at the point, and this is where the friction occurs.

The friction between lubricated leather or hemp, or rubber and metal, follows the laws of solid friction, and we have now described what friction of this kind occurs in hydraulic presses. The remaining source of loss of energy is the fluid friction.

In ordinary machines the friction occurs at the rubbing surfaces of solid bodies, and such friction is proportional to the load, and is almost altogether independent of speed. If anything, it is greatest at very slow speeds.

Here is an apparatus (Fig 7) which I designed in Japan to measure the friction between sliders, A, of all these different

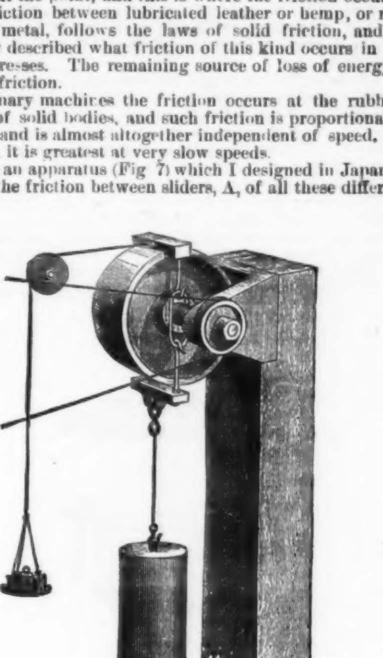


FIG. 7.

materials, and this cast-iron wheel, with very different loads on the sliders, and very different speeds of the wheel. You observe that the slider is at rest, and that its force of friction with the rim of the wheel is just balanced by the weight in this scale pan. The result is that there is no great difference in the friction at different speeds, and that the friction is proportional to the load on the slider. What, then, is the explanation of the well-known curious fact about railway brakes? It is this—in experiments on railway brakes there is no true friction; the material of the brake block is rapidly worn away; thus, in one of Captain Galton's experiments, *several* inches in thickness were removed in a *few* minutes.

I do not say that the rules for solid friction given in this wall sheet are absolutely true, but they are nearly enough true for your general acceptance, and you must not think that they conflict with the laws of resistance to abrading and polishing which have been found from **experiments on** railway brakes.

What, now, are the laws of fluid friction? One fact is well known to everybody, namely, that water is easily changed in shape. It takes the shape of any containing vessel. A bar of steel, if placed in a vessel, would probably remain a bar forever; it would not flow over the bottom of the vessel as water does. Now we have every gradation in character between steel and water. Steel can certainly be made to flow. It is drawn out into pianoforte wire. Many of you are aware of M. Tresca's interesting observations on the flow of metals. You have all seen copper wires drawn, and you know that many metals can be beaten or squirted out into other shapes without melting them; but, as a rule, great pressures are needed to perform these operations.

But the peculiarity of all substances which we call fluid is this: they will flow and change their shape, even when very small forces act upon them.

Thus you all observe this very rigid looking bituminous material, which breaks with a glassy fracture Now that material is a fluid. If I leave it piled up on this soup plate, you will find that after some days it will have covered the bottom of the plate, and that, although it flows very slowly, it does flow, even under the influence of its own weight.

Here, again, is a stick of sealing wax. You see that I can use it like a piece of wood to push or pull other objects with. But if I support its two ends, and leave it to itself, even its own weight is sufficient to cause a gradual bending, which is quite perceptible after a few days.

Now, between this rigid looking black mass and this liquid looking tar, I can obtain every gradation of fluidity, and all such substances are said to be viscous liquids. A liquid yields perhaps slowly, perhaps rapidly, but it yields to slight stresses tending to make it change its form.

Of course, water yields much more readily than any of these substances, but there is a certain amount of viscidity, which is quite measurable, and which gives rise to what we usually term friction.

If a man attempts to dive into water unskillfully, and falls prone, you know that the water offers a very considerable resistance to a change of shape. Now this resistance is not quite what I am talking about. This is mainly the resistance that any body offers to being rapidly set in motion. If you came colliding against the end of the most frictionless carriage, you would also experience its resistance to suddenly being set in motion; whereas the constant steady resistance to motion which the carriage experiences when moving with a uniform velocity is called friction.

What I am rather referring to is the resistance to the motion of water in a pipe, the resistance to the steady motion of a ship.

Fig. 8 shows a hollow cylindric body, F, supported so that it cannot move sidewise, and yet so that its only resistance to turning is due to the twist it would give this suspension wire, A. C C is water or other liquid filling the space between the cylindric surfaces, D D and E E, and wetting both sides of F. When the vessel, D D E E, is rotated, the water moving past the surfaces of F tends to make F turn around, and this frictional torque is resisted by the twist which is given to the wire. The amount of twist in the wire gives us, then, a measurement of the viscosity of liquids, and investigations may be made under very different conditions.

Fluid friction may be illustrated by similar and equal cylinders of brass, which you set hanging in air, water, and oil.

You will observe that, when the suspension wires are twisted and let go, the bodies vibrate like the balance of a watch. But it is only the one which vibrates in air that goes on vibrating for a long time; the one in water keeps up its motion longer, however, than the one in oil, showing that there is more frictional resistance in oil than in water, and in water than in air.

The rate of diminution of swing tells us the viscous friction of the fluid. Similarly, the rate of diminution of swing of the vibrating fluids in two U tubes, one containing water and the other oil, tells us about the relative coefficients of viscosity of the liquids.

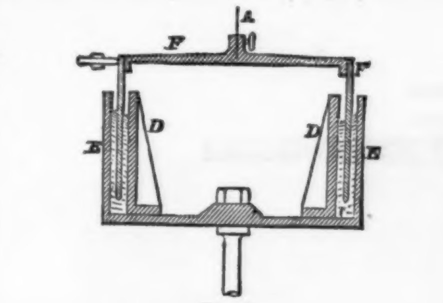


FIG. 8.

From experiment it is found that the force of friction in water is proportional to the wetted surface where friction occurs; it is proportional to the speed if the speed is small, but it increases much more quickly than the speed does. Thus, at the velocities of 1, 2, 3, etc., inches per second, the friction is proportional to the numbers 1,2, 3, etc., whereas, at the velocities of 1, 2, 3 yards, per second, the friction is proportional to the numbers 1, 4, 9, etc. At small velocities, such as these cylinders experience, three times the speed means three times the friction; whereas, at great velocities, such as those of ships, three times the speed means nine or more times the friction. You see, then that friction in fluids is proportional to the speed, if the speed is small; to the square of the speed, if the speed is greater; and at the greatest speeds the friction increases even more rapidly than the square of the speed. Even in such a fluid as air, the resistance to the motion of a bullet is proportional to the cube of the speed That is, a bullet of twice the velocity meets with eight times the frictional resistance from the atmosphere.

Again, it has been found that the friction is much the same, whatever be the pressure. Thus it is found that when this cylinder apparatus and water are placed in the receiver of an air pump, there is exactly the same stilling of the vibrations.

Here is an apparatus (Fig. 9), which illustrates the fact.

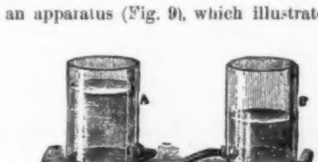


FIG 9.—POSITION M.

Water tends to pass from vessel, A, to vessel, B, by means of this long tube. Whether the tube is in the position, M, or N, we find the same flow through it, the same quantity of water passes through it per second; although, as you see, the pressure of the water in the tube in the position, N, is very much greater than in the position, M.

Again, fluid friction, for even considerable velocities, does not seem to depend much on the roughness of the solid

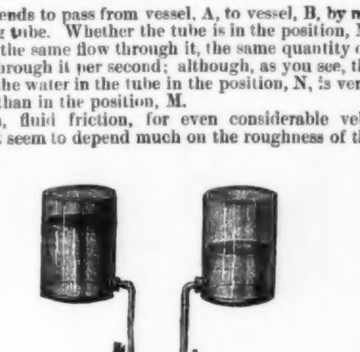


FIG. 10.—POSITION N.

boundary. The wall sheet compares fluid friction and the friction at rubbing surfaces of solids.

Friction between Solids.	Fluid Friction.
1°. The force of friction does not much depend on the velocity, but is certainly greatest at slow speeds.	1°. The force of friction very much depends on the velocity, and is indefinitely small when the speed is very slow.
2°. The force of friction is proportional to the total pressure between two surfaces	2°. The force of friction does not depend on the pressure.
3°. The force of friction is independent of the areas of the rubbing surfaces	3°. The force of friction is proportional to the area of wetted surface.
4°. The force of friction depends very much on the nature of the rubbing surfaces, their roughness, etc.	4°. The force of friction at moderate speeds does not depend on the nature of the rubbing surfaces.

You see now that in a hydraulic press, where the flow of water is everywhere slow, there cannot be much loss on account of fluid friction. Whatever loss there is must occur in these narrow passages, where the velocity is more considerable than in the press. But the grand distinction between it and other mechanisms lies in the fact that, when the motion is extremely slow, the fluid friction is extremely small.

The friction at the fulcrum of the lever we know about. The friction at these glands is simply due to the fact that metals rub on leather or hemp, and the pressure between the rubbing surfaces being proportional to the load, the quasi-solid friction is also proportional to the load. It is the friction at these two stuffing-boxes or glands which makes up the loss of power in all such machines as I am speaking about. For in all the machines which I am speaking about to-night, the water velocity is small, and the water friction can be neglected.

So small, indeed, is the fluid velocity, that when oil is used the loss would be much the same. Probably honey or tar would not give very different results; but the more viscous mixtures of tar and pitch would be unsuitable, because in these the fluid friction, at even such small velocities as we have to consider, would be considerable. I want you, however, to recognize the fact that even solid pitch would act as a fluid in the hydraulic press; but to obtain the same mechanical advantage as with water, you would require not to make more than one stroke of the plunger per month, and you would need to take exceptional precautions as to escape of the pitch by the joints.

I have one more general observation to make about the hydraulic press. I said there was no storage of energy in the press. This is not quite true, even if we disregard the compression of the water and elastic yielding of the press. There is a lifting of the ram itself always going on, as well as a lifting of the weight on its top.

Now, the lifting of the ram it is easy to take into account. In hydraulic presses you simply regard the ram as part of the load to be lifted, and you regard the lifting of it as an absolute waste of a not very large kind.

But when the weight lifted by the ram is less than the weight of the ram itself, and this is the case in warehouse and hotel hoists, it is usual to take it into account.

But it is rather difficult to take into account, because as it rises its weight gets greater. You know that a stone, when surrounded by water, is easier to lift than when it is in the air; and as more and more of a long ram leaves the press, the weight of the whole ram gets greater and greater, just in proportion to the weight of the water which it displaced.

I say that in hydraulic presses we can leave this out of account, but we cannot do so in hoists. In a future lecture I shall tell you how Clark and Standfield's balance method, applied to lifts, enables us to get over the difficulty.

The section of one of these lifting jacks you see in Fig. 11. Here the ram fits the pump barrel, and is made water tight by the India-rubber dish, C, fastened round the top of the ram by a screw. Now the motion of the working lever causes great pressure on a projection of the shaft, D, which communicates with the plunger of the pump, and gives it a downward motion, pressing the water in the pump-chamber, E, through the valve, F, into the reservoir, H, where it presses against the ram, which is firmly fixed. A small pressure on the lever thus forces more and more water into this water-tight reservoir, and necessitates the upward movement of the outer cylinder, B B. Thus the claw, I, lifts any weights that may be resting on it. The upward motion of the lever causes a partial vacuum in the chamber, E, as the plunger is withdrawn, and the air-screw being slackened, the pressure of the air and liquid in the cistern overcomes the resistance of the spring on the inlet valve, S, raises the valve, and thus effects a passage for the water into chamber, E. During the downward stroke the previously described operation is repeated. If we want to lower the weight, we open the lowering screw, and allow the water to return from the top of ram to the cistern.

The punching-bear, of which you have sections in Figs. 12 and 13, is similar in construction. The plunger, pump, valves, etc., are much the same as in the last case. The upper part of the stout ram, H, terminates in an India rubber dish, which is fastened by the washer and a bolt passing through the middle of the washer from the ram.

As you work the top lever, B, the ram, H, holding the punch is pressed down by water through a valve arrangement exactly similar to that in the lifting jack.

You are now well aware of the way in which the water in these machines acts. It is nearly incompressible, and tries to find an outlet in every direction. Try to bring your minds down to the consideration of what occurs from particle to particle of the water. Each particle presses on all its neighbors, because they all press in upon it, and it presses equally in every direction.

Wherever the water comes in contact with a solid surface, it presses against the surface, and the direction of this pressure is directly normal. There can be no such thing as oblique pressure in water when the water is at rest, for oblique pressure means a force partly along the surface, and this would imply some frictional resistance to sliding, which we know cannot occur in water at rest. It is evident from our discussion of the hydraulic press as a machine in which there is no store of energy, that on every square inch of the solid surface touched by the water there must be the same force acting, the water tending to escape everywhere; and when we consider the whole case mathematically, we find that every little interface separating any two portions of water is acted on by this same pressure per square inch.

You will, perhaps, some of you, have been troubled by the notion that the shape of the end of the ram ought to have some effect on the total force with which the ram is pressed upward.

You will be perfectly safe in all your notions of fluid presence, if you consider each particle of water to be a very small being, greased all over, so that it cannot possibly resist sliding past it neighbors. It can press normally against a wall, or against any surface, but there cannot possibly be a tangential or frictional pressure between it and a wall, because it is well greased.

All the water is trying to escape, and the total pressure on any surface is evidently proportional to the number of water particles pressing against the surface. Hence, if we have a piston, A, and a piston, B (Fig. 14), the total pressures on A and B are simply proportional to the areas of the cylindric tubes in which they can move. Evidently it is of no importance whether the inner surface of a piston has projections or not. Thus there is the same total vertical pressure on piston, M, and on piston, N, if the cross sectional areas of their cylinders are the same.

Everything depends on this—will they leave the same empty space behind them, if each of them moves one inch, and we know that in each case the empty space is simply one inch in length of the cylinder?

In the same way, although the end of the ram may be curved, as we see in Fig. 15, and it is therefore being acted on by a series of pressures, as in the figure, it is easy to show that the resultant action of these in the direction, A B, is really the same as if the ram had a flat end. Every one of these forces has a horizontal tendency, more or less, and when we leave out of account these horizontal actions, we get the same vertical result for all shapes of ends.

You will understand this better, perhaps, if we consider a vessel, A, B, C (Fig. 16), to be filled with fluid at such a great pressure that we can neglect the pressure due to the fluid's own weight. This we can do in the hydraulic press and in steam-boilers. The pressure on the surface everywhere is shown by the arrows.

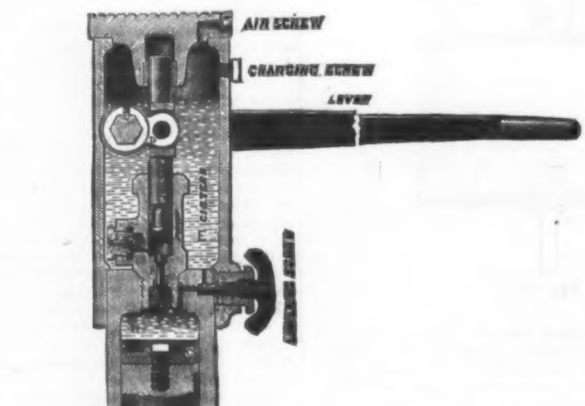
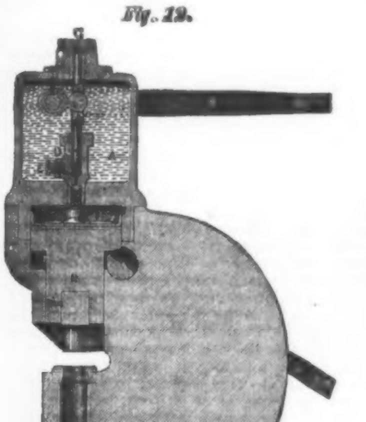


FIG. 11.

Now, it is evident that the total horizontal force on the curved surface, A, C, B, is exactly equal and opposite to the total horizontal force on the flat surface, A, B, because if there were, on the whole, more force on one than on the other, the vessel would move bodily, an idea which is absurd. Hence, when we want to find the total horizontal force on the curved surface, we never dream of going into the long calculation which you might think necessary, for it is simply equal to the area in square inches of the flat surface, A, B, multiplied by the pressure per square inch.

Hence, suppose we want to find the horizontal bursting tendency of the egg-ended boiler, M, N (Fig. 17); that is, say the force tending to burst it by direct pull of the iron at the section, A, B, we do not trouble ourselves with the shape of the boiler anywhere except at A, B itself. The bursting force is the inside area of A, B, in square inches,

Fig. 12.



multiplied into the pressure per square inch. The area of the iron in the section, A, B, is exposed to this pull. These are the two important facts to be remembered. Consider any section whatsoever of a boiler, or ram, or pipe. Remember that the fluid pressure is calculated over the whole area. The resistance of the iron is only calculated over the actual sectional area of the metal.

Thus, if we want to find the tendency to burst along such a section as M, N, we take the total inside area of the section, here multiplied by the pressure, and this is equal to the stress in the iron all along this section, multiplied by the whole sectional area of the iron.

In a cylindric boiler or press, which is everywhere of the same thickness, it is easy to show that, if we neglect the effect of the ends, the tendency to burst laterally is twice as great as the tendency to burst endwise.

Thus in the endwise bursting: If p is the bursting pressure in pounds per square inch, f the tensile strength of the material in pounds per square inch, r the radius of the boiler, and t the thickness of metal, the total force tending to produce bursting is the area of the circular cross section, $3{\cdot}14\ r^2$, multiplied by p, and the total force resisting fracture is the circumference of the circular cross section, $6{\cdot}28\ r$, multiplied by t and by f. Hence—

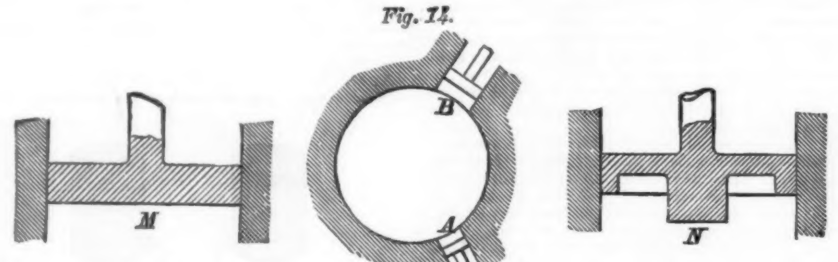
$$3{\cdot}14\ r^2 p = 6{\cdot}28\ r f t,$$
or the bursting pressure $p = 2 f t \div r$.

Again, if a boiler is l inches long, the total force tending to burst the boiler is the area l times the diameter of the boiler, multiplied by p, or $2\ r\ l\ p$, and the total force resisting fracture, if we neglect the ends, is the area of the iron $2\ l\ t$, multiplied by f. Hence—

$$2\ r\ l\ p = 2\ l\ t\ f,$$
or the bursting pressure $p = f t \div r$.

Hence it would take twice as much pressure to burst the boiler if we assumed it to burst endwise. We always calculate the strength of a pipe or boiler on the second assumption, therefore, and we have the rule: The bursting pressure in pounds per square inch is equal to the tensile strength of the metal in pounds per square inch multiplied by the thickness of the metal in inches, divided by the radius of the boiler or pipe in inches.

Fig. 14.



When the press is thick, as we find it in a hydraulic machine, it is rather more difficult to calculate the bursting pressure, because the tensile strain is not distributed uniformly over the section at which there is a tendency for rupture to occur. The inside portions of the metal near the water are subjected to more pulling forces than the outer portions.

Fig. 15.

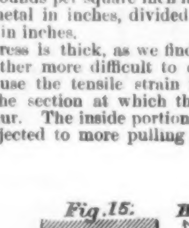


Fig. 16

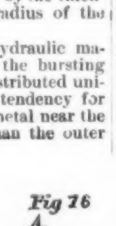
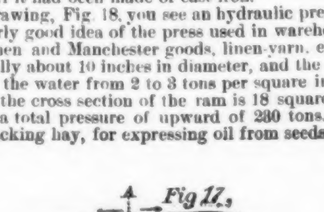


Fig. 17.

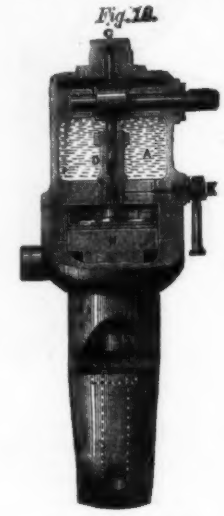


Mr. Barlow, in a paper read before the Institution of Civil Engineers, some years ago, computed the bursting pressure of thick cylinders; but there was a defect in his reasoning. Lamé was more correct in his investigation. Rankine and others have obtained the same result as Lamé, but in different ways. Now, I do not mean to consider these calculations with you, for although they are very interesting mathematically, they are practically useless. You may, however, be interested in the result arrived at. Neglecting the strength of the ends, the bursting pressure, multiplied by the sum of the areas of the outer and inner circles of a cross section of the cylinder, is equal to the strength of the metal multiplied by the area of the metal exposed in such a cross section. This rule you will find applicable to thin cylinders as well; it is the same rule as the one already given. You see that if the fluid pressure is equal to the tensile strength of the metal, no thickness of the cylinder can prevent its bursting.

The investigation might perhaps have some use if iron, when it leaves the foundry, had all through its thickness the same qualities and a perfect absence from strain. It is good to remember that an iron casting, when it leaves the foundry, although not quite so curiously strained as a Prince Rupert's drop or toughened glass, is yet in a state of strain which we know very little about.

The above investigation shows that in a thick cylinder there is an exceedingly great difference in the tensions of the inner and outer portions of the metal of a gun or hydraulic press. For the purpose of producing a more uniform state of stress, the inside portions of the metal are often chilled—that is, the metal in the inside is very quickly cooled after

Fig. 18.



it is cast. The result is that these portions are virtually in a state of great compression, and hence, when the regular strain occurs through water pressure, there is a considerable tensile yielding in the inner portions of metal before the bursting tensile stress is reached there; and hence, with a proper amount of chilling, it is possible to have the tensile stress in the metal nearly uniform when fracture is ready to occur. In such a case as this, the calculation of the bursting pressure of a press is just the same as if it were thin.

Cast steel is now getting common for the cylinders of small jacks and bears. The large presses used in warehouses are, however, still made of loam-moulded cast iron, as all presses used to be in my apprenticeship days. But in a great deal of large press work, cast steel has come largely into fashion, its tensile strength being so much greater than the strength of cast iron as to make a most extraordinary difference in the outside sizes of the cylinders. Thus, for example, in a Wilson-Cotton press, it enabled three cylinders to be placed side by side in a space which would only have allowed one to be used if it had been made of cast iron.

In this drawing, Fig. 18, you see an hydraulic press which gives a fairly good idea of the press used in warehouses for bales of linen and Manchester goods, linen-yarn, etc. The ram is usually about 10 inches in diameter, and the working pressure of the water from 2 to 3 tons per square inch. As the area of the cross section of the ram is 18 square inches, this means a total pressure of upward of 230 tons. When used for packing hay, for expressing oil from seeds, and for other purposes, alterations are made in the shape, length of standards, and, indeed, in the size of all the parts. In expressing oil, for example, there would be an alteration in the arrangement of the table or platen and the head. Sometimes the table became a piston, fitting into a cylinder attached to the head. Usually, however, the arrangement is what you see. If yarn has to be pressed, it is placed in a great oak box, bound with iron, running on wheels. It is

run in between two of these columns. The pumps work, a movable bottom of the box rises up, the pressure on the yarn gets greater and greater, and when about 230 tons is the total force, the yarn, very much diminished in bulk, is tied up, the ram descends, the great box is rolled out, and another loosely filled one is rolled behind it to undergo the same process.

For warehouse use, the pumps are often worked by hand, but even fifteen years ago I remember that orders were generally for pumps worked by power—that is, driven from shafting and worked by cranks. In this case it was common to attach a series of these presses to one set of pumps, all the presses in a warehouse being fed from a long pipe, each having its separate valve.

You will see that, although in hydraulic jacks for lifting heavy weights the weight on the ram is the same during the whole of any operation, this is not the same in baling presses. Thus, for example, in the Indian cotton trade, governed as it is by the Suez Canal regulations, it is necessary to press cotton so compactly that it is like a piece of oak, and it can be planed up like oak.

During the early part of the operation, the pressure on the ram is therefore small, becoming very great toward the end; and it is the greatest pressure, of course, which decides the relative sizes of plunger and ram. If the ram were made to rise quickly at the beginning, and more slowly toward the end, it is obvious that there would not only be a saving of time, but a more regular doing of work.

In hand-presses it is usual to change the fulcrum of the lever, so that a laborer may work more rapidly at the beginning. It is also common to use a large pump in the early part of a pressing operation, changing it to a small one at the end; or to use two of equal size, throwing one of them out of gear toward the end of the operation.

The diagram of Wilson's hydraulic cotton-baling machine shows an earlier form than the one used at present. Instead of using one large ram, three are used. At first only the center press is connected with the pumps, and of course it rises quickly; meanwhile the other two are filling with water from a tank, but the pressure of the water in them is insignificant. As the operation proceeds, one of the side presses is disconnected from the tank, and is now fed from the pump. The operation proceeds more slowly now, as the pump has to supply two presses instead of one; but the possible total pressure is doubled. Toward the end of the operation the third press is disconnected from the tank, and is connected with the pump; the operation proceeds more

FIG. 18.

slowly still, although the pump may be working at much the same speed as in the beginning. But the possible total pressure is just three times what it would have been with only one ram.

A later form is shown in another diagram. There are twelve pump-plungers attached directly to the cross-heads of the steam-engines. At the beginning all twelve are working, as the pressure is small. Then, as the pressure gets greater, one set of four pumps is detached, so that they do not pump water into the press, but merely pump water back to the cistern from which they draw it. Thus eight pumps are now pumping, forcing into the press less water than the twelve did before, but as they have the whole steam piston force acting on them, they are able to force the water in against a very much greater ram pressure. Later on in the operation, four more pumps cease to act.

One further improvement is to be noticed. The head or platen has two long columns attached to its under side, hanging down. When the first operation is finished, the bottoms of these columns are just above the base, and may be locked firmly, so that now the head cannot fall back again. Now the finishing-stroke is made; two 19" rams are pressed downward on the upper end of the bale with a much greater pressure than it was possible to apply with the bottom 11" ram.

Watson's cotton-press is somewhat the same. He uses fewer pumps, but he uses two bottom presses and rams instead of one. He also uses the larger rams for pressing downward from the top of the press to finish the operation. He is able to perform the finishing pressure operation, however, when the bottom ram is being withdrawn, so that one bale is being finished in the upper part of the press when the box is being filled with cotton for a new bale. Here is a diagram which gives the nature of the pressures to which a cotton bale is subjected.

When the lower ram has risen 11 feet, the pressure is only 8 tons; but in another foot the pressure increases to 16 tons; in another foot, to 33 tons; and in another, to 59 tons. The upper rams begin to operate when the total pressure is about 160 tons; but on moving through 3 inches, they had to exert 200 tons; three inches further, 300 tons; three inches further, 500 tons; and three inches further—that is, when the ball was finished—they were exerting a pressure of 900 tons.

We see, then, that capability of working very rapidly when the pressures are small, and working very slowly when the pressures are great, on the supposition that the steam-engine is always working at the same speed—these are the important things to be looked for in hydraulic presses. It must be quite evident to all of you that there will probably be great changes in the future in these machines. Probably it is in the direction of the use of combinations of accumulators, employing Mr. Tweddell's principle, that we may look for improvements.

CAVE'S BREWING APPLIANCES.

AMONG the many interesting examples of brewing machinery and appliances denoting modern progress with which we met at the Brewers' Exhibition, we may certainly class those exhibited by Messrs. Llewellins & Jame of Castle Green, Bristol. Three of their leading exhibits are with the malt. Thus, while by the admission of steam to the rotating plows, the temperature can be raised to boiling point, which is necessary for bursting the starch cells, so, by the admission of cold liquor to the plows, the temperature can be readily reduced. The steam or cold liquor passing through the plows does not come in contact with the mash. The method of conducting the mashing operation is very simple, and briefly is as follows: A certain proportion of maize or other raw material and malt are mashed together at a low initial heat; steam is then admitted into the plows, raising the mash to a certain point, at which it is for a short time allowed to stew; the heat is then raised to boiling point, and the mash is boiled for a short period in order to burst the starch cells. The steam being then shut off, cold liquor is admitted to the plows, which quickly

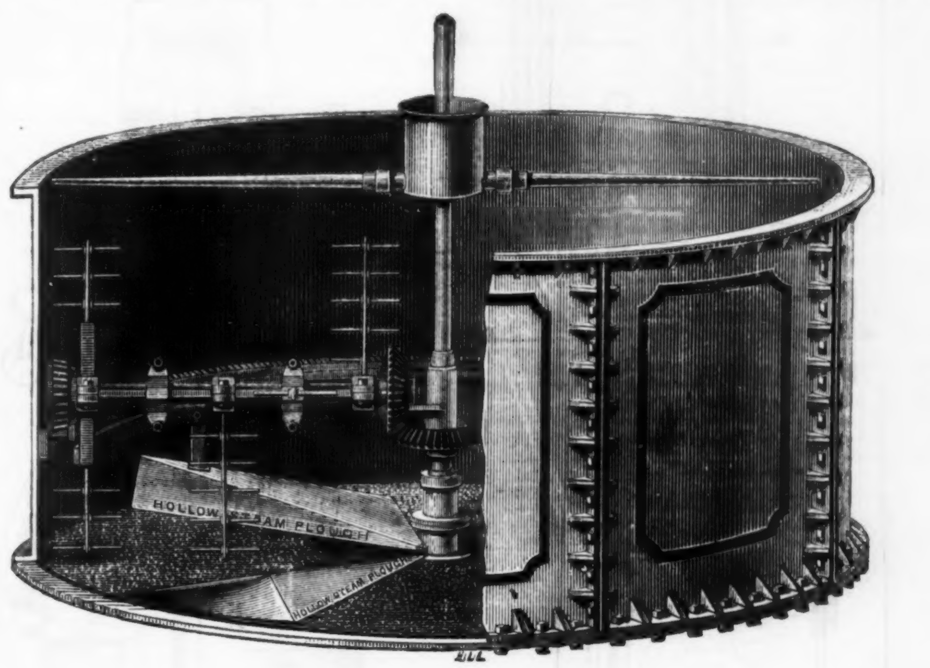


FIG. 1.

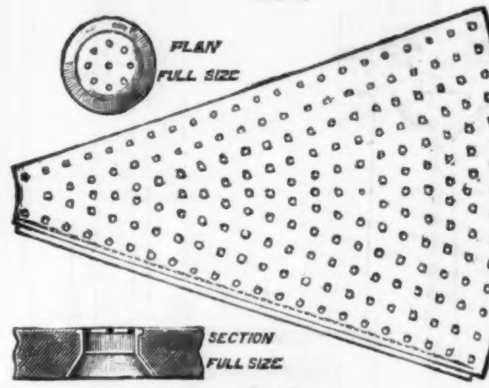


FIG. 2.

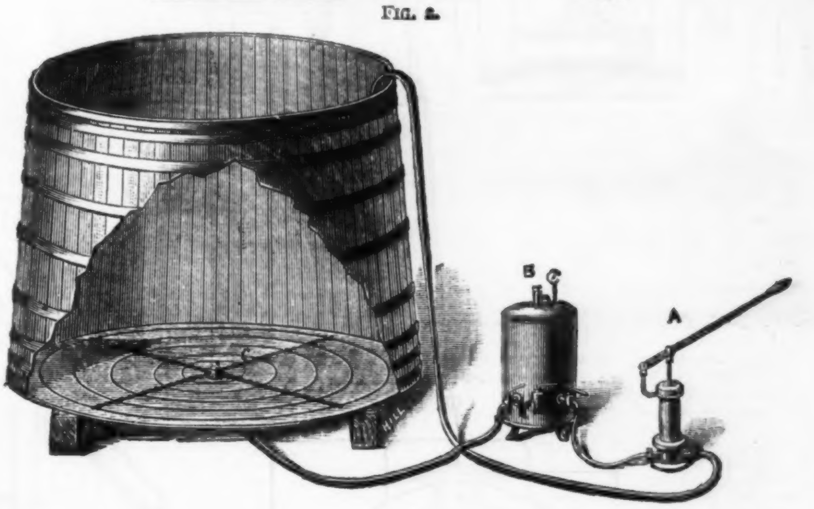
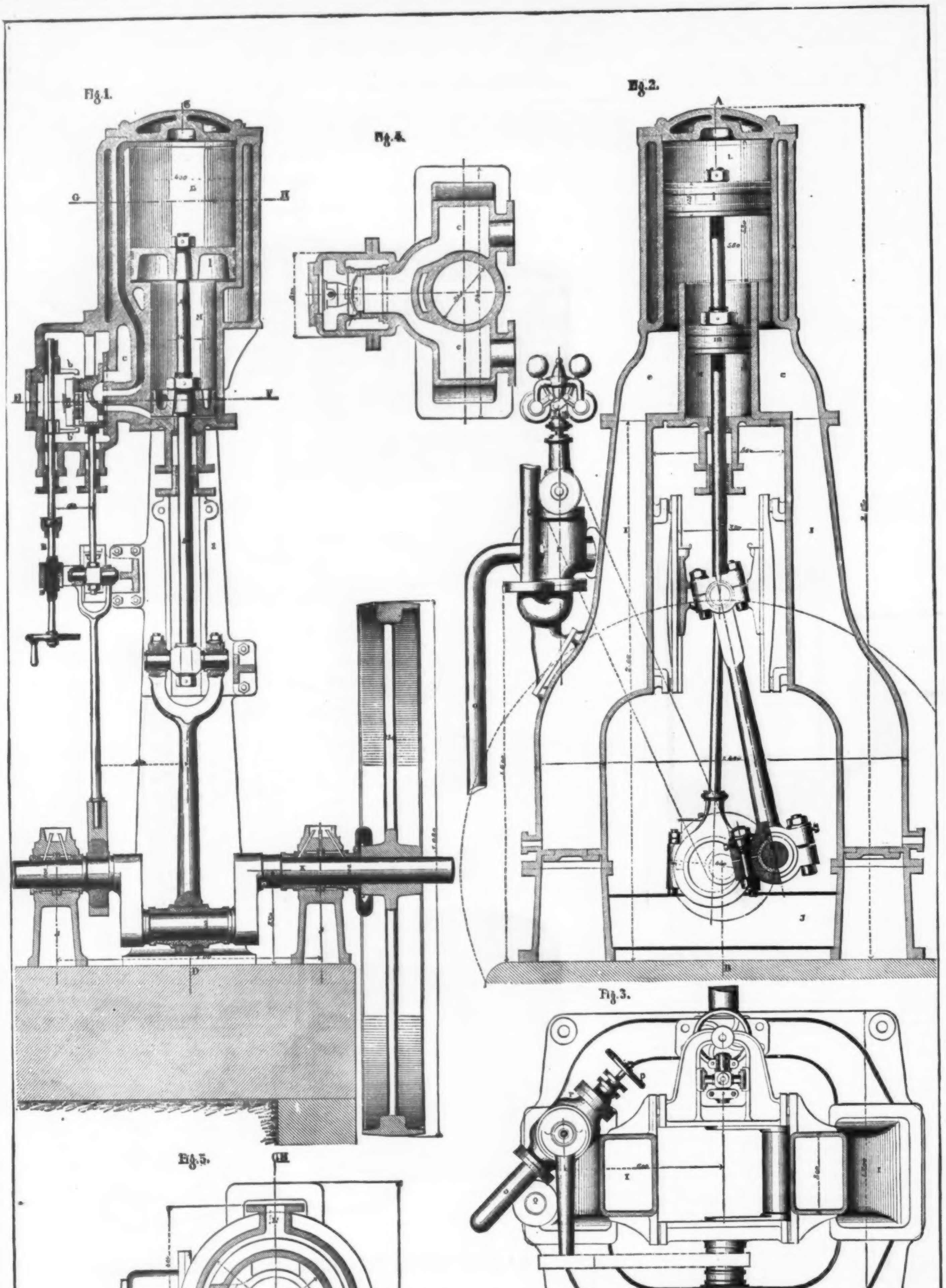


FIG. 3.

CAVE'S IMPROVED BREWING APPLIANCES.

illustrated in the above engravings. Of these Fig. 1 represents Cave's raw grain and malt mashing machine, which is applicable to any existing mash tun, whether of wood or iron. It insures perfect saccharification of maize, rice, or other raw material, and necessitates no additional plant of any description for effecting the conversion of starch into sugar, while for a small cost existing plants can be altered to suit this new system. The diastase contained in malt being the only medium employed, no acid or alkali is necessary to obtain the required conversion. By reference to our illustration, it will be seen that a hollow shaft is substituted for the ordinary solid shaft employed in raking plant, around which the rakes revolve, and to which are attached two hollow plows or blades. From the hollow shaft either steam or cold liquor is admitted to these hollow plows as required, which by their peculiar shape scrape the false bottom plate and thoroughly mix the raw material reduces the temperature to the normal mashing heat, and the remainder of the malt is then mashed in the usual manner. We understand that this machine has been in work in several breweries for many months and during hot weather, and that both with raw grain and imperfectly cured malt it has given every satisfaction, yielding large extracts thoroughly converted.

Fig. 2 of our engravings represents a segment of Cave's copper inserted cast iron false bottoms for mash tuns, etc., the perforations being shown of the full size in plan and section. These bottoms have been designed especially to meet the requirements of the altered system of mashing since the introduction of raw grain in brewing. It combines the strength, rigidity, and cheapness of cast-iron with the fineness of perforation to be obtained only in copper, and insures perfect drainage. Fig. 3 represents another invention of Mr. Cave's, and which, like those previously de-



FARCOT'S COMPOUND VERTICAL ENGINE.

scribed, is manufactured by Messrs. Llewellins & James. This is a rouser, aerator, and gyle equalizer. A is a small air pump, B an accumulator, and C the rouser. By the use of this apparatus a system of fermenting is introduced, which at the present time is not generally understood, but as the necessity for a knowledge of chemistry as an applied science to the art of brewing is more generally recognized, the economic value of this system will become so self-evident as to secure its general adoption. A few words explanatory of the chemical action exerted by its influence may perhaps be of interest to some of our readers. Wort is proportionally richer in soluble gluten and other viscous constituents than it is in sugar, and when set to ferment in the ordinary way, it evolves a large quantity of yeast in the state of a thick froth with bubbles of carbonic acid adhering to it, whereby it is floated to the surface of the wort. Now the conversion of gluten, etc., into yeast is partly, at least, a process of oxidation, and when the wort is covered with a thick froth or scum, a portion of the gluten remains dissolved in the wort, and not having access to the air it takes oxygen from the sugar and other matters contained in the wort. The result is that the sugar is destroyed before the whole of the gluten is converted into yeast. Thus a quantity of free gluten is left in the wort, and on subsequent exposure to the air this gluten acts as a ferment, inducing the conversion of the alcohol into acetic acid. By the use of this apparatus, this, it is stated, is avoided, as air containing free oxygen is passed upward through the gyle, and coming into direct contact with the free gluten contained therein, converts it into yeast by atmospheric oxidation, and removes it wholly from the gyle. The sugar remains undecomposed, improving the flavor and effecting a saving in cost. Altogether, these inventions denote scientific progress in the art of brewing, and therefore are well worthy the attention of those whose interest it is to move with the times.—*Iron.*

FARCOT'S COMPOUND VERTICAL ENGINE.

REFERENCES TO FIGURES OPPOSITE.—Fig. 1. Section through A B; Fig. 2. Section through C D; Fig. 3. Plan view; Fig. 4. Section through E F; Fig. 5. Section through G H.

For actuating the blowing machines of his invention, Mr. Denis Farcot, of Paris, has devised a compound upright engine of variable expansion, which is illustrated herewith. This engine works with two cylinders, one piston rod, one slide valve, and one stuffing box. It consists of a cast iron frame, I, quite similar to that of a power hammer, bolted to a base, J, with which are cast in a piece the plumber blocks that support the driving shaft, K. This latter is cranked, and is provided with a journal, K', on which is adjusted the bearing of the connecting-rod head.

The frame, I, is surmounted by two vertical cylinders, L and M, which are cast in a single piece, and contain two pistons, *l* and *m*, that are fixed upon a single rod, N, and have different diameters. Upon the side of the smaller cylinder, M, is mounted a steam chest containing a three port slide valve and the expansion mechanism. The slide valve is moved in the usual way, by an eccentric keyed upon the driving shaft. The expansion mechanism is regulated by hand.

The steam enters from the boiler through the pipe, O, traverses a port, P, that is opened by a hand wheel, *p*, passes into the pipe, Q, and finally enters the jacket of the large cylinder through an inlet, L', located at the side. This jacket communicates with the steam chest.

The two motive pistons, *l* and *m*, are single acting, that is to say, the steam acts upon the piston, *m*, only when it is rising, and only upon *l* when it is descending. The steam, under full pressure, enters first under the small piston and causes it to rise until the expansion plate closes. It then expands, and the piston continues its ascensional motion. When the piston has reached the end of its travel, the slide of the valve sets up a communication between the under side of the small piston and the upper side of the large one, and the steam enters the cylinder, L, stops expanding, and forces the piston, *l*, to descend, and then escapes through the space, *e*.

The expansion mechanism consists of a plate adjusted to the slide valve, and having orifices corresponding with those of the latter. A vertical shaft, R, having a thread at its lower part, revolves in a stationary nut, *s*, and carries along, in rising and descending, a movable stop, *b*, and this latter stops the expansion plate when the slide valve is rising, and closes the orifices. Consequently, the position of this stop determines the moment at which expansion shall begin. The lower stop, *b'*, which is stationary, serves to set the orifices of the plate opposite those of the slide valve when the latter redescends.

The regulator is of the Buss system. It acts upon a valve of ordinary form, and is set in motion by a belt running over the driving shaft. The head of the piston is fixed upon two slides, which run in a double guide bolted to the uprights of the engine frame.

This engine, which is of 15-horse power, weighs about 13,000 kilogrammes. Running normally, it makes 120 revolutions per minute with a consumption of two kilogrammes of coal per horse and per hour without condensation.—*Annales Industrielles.*

COFFEE TAVERN AND HOSTELRY.

THIS building, of which we give an illustration, was opened recently by Lady Ossington, who has erected and endowed it, at her own cost, for the benefit of the inhabitants of the town, near which is her residence, Ossington Hall. The architects were Messrs. Ernest George & Peto. The building is arcaded along the principal front in the manner of many old houses in Newark. The arcade will form a pleasant shelter in hot or wet weather, and tables can be placed here for those who like to take refreshments in the open air. There is also a large garden on the river side of the tavern, overlooking the Trent, and its bridge, formerly a part of the town ramparts. This garden has an entrance from the bar, and here refreshments will be served, while music will be provided in summer evenings, after the custom of the pleasant German "Biergarten." Along one side of this garden is an alley for American bowls. The ground floor is occupied by a large bar, adjoining which, on the same floor, are the kitchen and offices. A smaller bar, separate but served from the same counter, forms a room for boys, the separation of whom from the men is very necessary. There is also a small manager's parlor adjoining the bar. A separate entrance and staircase leads to a large assembly room on the first floor, a room that will be used for concerts, lectures, and various large meetings, as well as for the farmers' ordinary on market days. On the first floor are also a reading room and a club room, for the meetings of the various friendly societies. The second floor is formed in the spacious roof, where is provided a large billiard room for two tables, "cubicles," or dormitories, for twelve lodgers, as well as for the rooms for the manager and servants. A bath room is provided for the use of the cubicles, and lavatories, convenient for billiard room, assembly room, and the yard. There is also a ladies' cloak room. Externally the building is treated with an arcading of red brick, and above these arches the mullioned bay windows project. There are wide spreading eaves and moulded cornices above, against which these bay windows stop. Above are long mullioned windows, over which the gables are filled in with oak framing and paneling, and the general effect is shown in our engraving. —*Illustrated London News.*

SUGGESTIONS IN ARCHITECTURE.—A COFFEE TAVERN AND HOSTELRY AT NEWARK ON TRENT.

THE MANUFACTURE OF WINDOW GLASS.

WINDOW glass may be regarded as of three kinds—crown, cylinder, and plate. The two former alone are generally spoken of as window glass, though plate is largely used for windows. They differ both in material and method of manufacture, the cylinder glass being the most inferior kind.

Though known to the Egyptians at a very remote period, glass appears to have been little used for illuminating purposes by the ancients. Rome had but a few glazed windows in the reign of Nero. Its use seems to have gradually become more general during the dark ages, principally, however, in ecclesiastical edifices.

Glass windows were placed in the monastery of Weremouth, A.D. 647. St. Jerome, who wrote early in the fifth century, and Gregory of Tours, who wrote in the sixth century, mention glass windows. The use, however, was not general in the twelfth century. Henry III., of England, had glass windows in his palace of Woodstock, 1205, and at Westminster. Chaucer mentions them. Scattering mention is made of them in succeeding ages, and they became common in farm houses about 1600.

The Venetians led the way among European nations, and attained great excellence, both in quality and taste of design; their ware was regarded with admiration, and has been preserved in England among other articles of vertu.

A factory was established in England in 1635, about which time pit coal was substituted for wood. In 1670, Venetian artists were introduced into England, and established the art in that country.

Casting glass was invented by Theraut, a Frenchman, in 1688, and was introduced into England, at Prescott, in 1773.

The art of coloring glass was well understood in ancient Egypt. Stained glass was originally a mosaic, made up of different pieces, arranged, according to color, to form a design. About 1500, a French artist at Marseilles incorporated colors with the glass, which were baked in.

The first authentic record we have of window glass making in this country was at Braintree, Massachusetts, in 1635. The industry afterward spread to New York, New Jersey, (where it was made during the Revolutionary War), Pennsylvania, and elsewhere. Plate glass has been made in the United States for only ten or twelve years.

Cylinder glass is made by a succession of operations, in which the material is brought to the shape of an open-ended cylinder, which is split asunder and flatted in a furnace.

This mode of making flatted glass is not new; it is described in the "Diversarum Artium Schedula," written probably in the thirteenth century.

The process of making cylinder glass is as follows: The workman collects a mass of the glass around the end of his blowing tube, and then distends and rounds it by blowing and rolling on the marver, or flat cast-iron table. The subsequent operations consist in reheating, blowing, and swinging, until the diameter and then the length of the cylinder required are attained, the glass assuming several different forms in the process. In the fourth stage, when it has assumed the conoidal shape, the point is very thin, and the blower, having filled the shell with air at a pressure, places it in the furnace, when the expansion of the air by heat causes the conoid to burst at the apex. The edge of the hole is then turned with shears and enlarged with the pucellas, a peculiar hand-tool, which resembles a pair of spring sugar tongs with flat jaws. The cylindrical form being then perfected, the cylinder is ready to be removed from the blowing tube, a circular piece of glass coming away with the tube so as to make an opening in the other end of the cylinder. This separation is effected by a red-hot bent iron, in which the cylinder is turned round a few times, so as to expand the glass at that point. A drop of water on the heated line makes an instant fracture. The cylinder is then split by a diamond or by means similar to that which removed the disk from the end of the blowing tube.

Flatting and annealing finish the process. These are accomplished in separate furnaces or apartments heated by the same furnace. In the combined form, it consists of consecutive chambers heated by a furnace beneath. The cylinder is placed on the heated floor of the flatting furnace, with the cracked sides uppermost; the heat of the furnace causes it to soften and spread out, when all curves and lumps are removed by a straight piece of wood, fastened crosswise at the end of an iron handle, and wetted before applying. The flatting stone is made very smooth, as any irregularities are transferred to the glass. The sheet of glass is then pushed into the annealing chamber, where it is set up on edge and left to cool gradually.

The process of making crown glass, which is in some respects similar to that of making cylinder glass, is as follows:

The materials are fritted in a reverberating furnace, and

then melted in a pot. A lump of glass sufficient to make a "table" of nine pounds weight is extracted at the end of a blowing tube, and is distended into pear shape by blowing through the tube and rolling on the marver, which is a cast-iron slab on a stand. Being softened by heat at the mouth of a small blowing furnace, it is rolled on the marver and blown till it assumes a more spherical shape, but has a conical end, which is removed as the glass approximates a spherical form, being blown as it is rolled on the bullion bar. Being again heated at the blowing furnace, it becomes spherical. It is then presented at a larger furnace hole called the bottoming hole, and being rapidly rotated becomes oblate. A pontil tipped with molten glass is then applied to the center of the flat portion, and the blowing tube is detached by touching the neck of the globe with a cold, wet iron. This leaves a hole in the end from which the blowing tube was detached. Heat and rotation being still applied, first at a furnace opening of moderate size called the nose-hole, and then at a much larger one called a flashing-furnace, the hole becomes more and more enlarged as the article becomes more and more oblate. Finally it flies open with a sharp, rustling noise, and appears as a flat plate, called a "table," adhering at its central thicker portion, the bull's eye, to the pontil, by which, during the latter portions of the process, it was rested on the hook in the half-wall before the furnace, which formed a partial screen for the workman.

When it has cooled sufficiently to be rigid and not liable to bend or collapse, it is placed on a fork, the pontil detached by the application of a cold iron, and the "table" placed in the annealing arch, or kiln, where it rests on its edge for perhaps twenty-four hours, gradually cooling. The annealing arch is termed a lear, and this is often made continuous; the trays holding the ware traveling from the hot to the cool end, being carried along as the trays of recently made glass are received at one end, while the contents of the trays at the discharge end, having cooled sufficiently to bear handling, are removed.

The size of a "table" or disk of crown glass is about fifty-two inches, and a pot holding one half ton will make about 100 "tables."—*Glassware Reporter.*

SUBSTITUTES FOR GROUND GLASS.

MANY occasions for the use of obscured glass might arise when the expense of a special piece would not be justified; for example, if it were only required for a temporary purpose, or on a large scale, when fineness of surface was not essential. In such cases the knowledge of a means of quickly rendering an ordinary sheet of glass suitable for the purpose will be very useful.

The simplest and most efficient plan is to varnish it with a special varnish which will dry with a matte surface. There are several such to be found in commerce; but, as they are not very difficult to make, we give two formulæ, both of which are recommended as giving a solution that will dry quite matte without the application of heat.

No. 1 is made by preparing the two following solutions separately and then mixing them together, the mixture being ready for use after a day's rest:

SOLUTION A.

Absolute alcohol	2¾ ounces.
Gum sandarac	⅛ ounce.
Turpentine	1½ drachms.
Oil of lavender	1 "

SOLUTION B.

Alcohol	5½ drachms.
Ether	⅓ drachm.
Camphor	1⅓ "
Distilled water	2⅔ drachms.

No. 2 is a simpler form, and we believe answers as well as, if not better than, the more complex one just given:

Mastic	50 grains.
Gum sandarac	⅙ ounce.
Ether	5½ ounces.

Powder the gums and add to the ether, and shake till dissolved; then filter or pour off from the sediment after standing a while, and add of benzole from two to two and three-quarter ounces, beginning with the smaller quantity and testing till a surface of the right degree of fineness is produced upon evaporation. The bottle containing this solution requires to be exceedingly well corked, or the contents evaporate in unequal proportions and cause the varnish to dry with a coarse grain, the exact proportion of the solvents for dilution not being readily hit upon.

For purposes where a surface of the most extreme delicacy is required, we have it on the authority of a very eminent optician that a solution of gutta-percha in chloroform surpasses everything else. It would be rather an expensive varnish, and one to be carefully used; but if the eulogiums bestowed upon it be justified, there can be no doubt of its extreme usefulness in some cases.

Another easily applied coating is a thin starch—arrowroot, corn flour, etc.—solution, which when dry leaves a very fair kind of surface to receive the image. Some photographers employ a coating of new milk, and where none of the above-mentioned ingredients are at hand it affords a substitute by no means to be despised, as does also a coating of ordinary varnish thinned with spirit and applied cold.

Mr. W. B. Woodbury some little time ago published a simple but most effective method of producing a dead white, opal-like coating upon glass. It consisted of mixing together ordinary negative varnish and uniodized collodion, and pouring the mixture cold upon the glass. When dry, the result is a beautifully-matte white surface, very solid and opaque-looking. Upon trying it for the first time, it struck us as being the very thing for a simply made substitute for ground glass; but, to our disappointment, it did not approach the benzole and ether formula (No. 2) as above. It required a considerable amount of dilution to make it in any way transparent enough, and when so altered it was too irregular and coarse-grained to be of use for any but rough work.

Not to make our remarks extend to too great a length, we will conclude our review of methods by alluding to those extemporized plans needed to remedy some disaster or accident, as, for instance, when a foot is put through a focusing-screen; or when, at the end of a long journey and far away from all glaziers, it is found that some extra severe concussion has broken the glass to pieces. To indicate any of the virtues of one varnish over another at such times, or of the need for a specially prepared obscured glass, would only be to increase the weight of the tourist's sorrow. We imagine that in the majority of cases the supplying of a piece of glass to size would be the most serious difficulty; but, that being overcome, it is a slight matter so to prepare the glass as to make it answer all practical purposes as a stop-gap. Putty, used as a dabber over the whole surface of the glass, is often recommended; but we rather suspect that where putty could be found there also might a glazier be discovered; but there are few places where a piece of soap could not be obtained; and a piece moistened and rubbed over the surface will often serve to focus upon. A sensitive plate, wet or dry, has been used, as our columns will testify, many a time for the purposes we are discussing; but, though better than nothing at all, it forms but a poor substitute, owing to its opacity, compared with the other methods we have detailed.

Finally, we describe one method which would be available almost everywhere, and that is a piece of white paper—tissue paper, if possible, or writing paper, if none other be available. It should be wet and placed over the inner surface of the screen frame, and, when dry, oiled or varnished to render it translucent. With some shapes of screens, where the glass is not flush with their faces, it may be requisite to make an allowance in the focusing; but there would be no difficulty in the matter. With this recommendation we close the subject, feeling assured that one or other of the methods we have described would enable the photographer to meet almost any emergency.—*Br. Journ. of Photo.*

SILVER IODIDE IN PHOTOGRAPHIC GELATINE EMULSION.

THE iodide question is by no means properly understood at the present time in all its bearings; but the recent experiments of Schumann not only serve to throw some new light on the matter, but will doubtless lead to a further and closer experimental study of the subject. Fresh exposures made on some of Herr Schumann's plates, about nine months old, proved that with bromo-iodide films the action extends notably beyond that visible in the case of bromide plates, and that this difference becomes increasingly great as the light is richer in the rays corresponding to low rates of vibration. A difference was clearly noticeable in the case of pictures taken at various hours of the day, in some of these instances the bromo-iodide and pure bromide plates being simultaneously exposed with twin lenses; a rough estimate being that the iodide plates are double as sensitive as corresponding pure bromide films. This relative sensitiveness, however, appears to be very widely departed from in the case of exposures made by petroleum light; as, when twenty to thirty minutes were required to impress a mere trace of an image on a bromide film, a similar exposure of a bromo-iodide plate gave a negative which, if not fully exposed, was at least capable of serving as a makeshift. A study of these results leads to the conclusion that when the light is specially rich in yellow and red rays, the bromo-iodide plate is not merely twice as sensitive as the bromide plate, but rather six or eight times as sensitive.

Schumann's spectrographic experiments are equally surprising; as not only did an attempt with the light reflected from a grayish evening sky serve to impress a tolerably extended spectrum on a bromo-iodide plate, while a similar exposure would scarcely affect the bromide film, but with the highly actinic light of burning magnesium a striking difference was noticeable. About two grains and a half of magnesium wire, burned an inch from the slit of the spectroscope, served to impress a vigorous spectrum on the iodide plate, the characteristic band in the green being notably well defined; while a similar experiment made with a bromide plate resulted in the production of a weak image in which above mentioned band was altogether absent.

It is curious to note that the remarkable difference between bromo-iodide emulsion and pure bromide emulsion appears to be greater in proportion to the extent to which the former has been treated with ammonia; at least, one would gather from Herr Schumann's experiments that this holds good up to a certain point, and the circumstance is of special interest when it is remembered that silver iodide is practically insoluble in ammonia.

Unless there is some notable and unobserved source of error in connection with Schumann's experiments, we may expect them to lead to an important advance in the struggle for extreme sensitiveness, a quality of special importance when feebly actinic light is alone available.—*Photo. News.*

IMPROVED METHOD OF PHOTO ENGRAVING.

IN a recent lecture by J. Comyns Carr, the following process invented by Henry Dawson is described:

"Mr. Dawson makes no great secret of the principle on which his process is founded, and I may therefore briefly explain to you the ingenious mode in which admirable results are obtained. You will observe, in the first place, that these are impressions from metal plates, printed in the same manner, and by the same press, as a copper or steel engraving; but instead of the picture being engraved upon the plate, as one might expect, the plates are themselves, so to speak, produced upon the picture. It is the picture in Mr. Dawson's process which really creates the plate; and the way in which this is accomplished is so remarkable that perhaps you will allow me to give a few words of explanation. The first thing that Mr. Dawson does, after having photographed his subject, is to take from his negative a carbon print; this print is taken, not on paper, but on glass; and as the principle of a carbon print consists in the deposit of solid pigment, the picture so taken upon the glass represents a very delicate work in relief; that is to say, the surface of the picture is very slightly raised upon the smooth surface of the glass. This impression is then covered with a thin coating of gold, which acts as a powerful conductor of copper, and the glass is now placed in a galvanic bath, where the copper is gradually deposited over the whole of the plate. When the deposited copper has attained a sufficient thickness, it is taken from the bath, and the glass is removed. We then have a copper plate with the picture cut upon its surface, exactly corresponding to the carbon print; that is to say, those portions which in the print were in relief are now in intaglio, and every delicate gradation is exactly reproduced as in the original negative. The copper plate now resembles, in every respect, the work produced by the engraver. According to the character of the original, it partakes of the nature either of an engraving in line, or of a mezzotint engraving, and it is this quality of mezzotint surface which Mr. Dawson rightly regards as constituting the special claim of his invention. The difficulty here with which he had to contend was to give such a surface as would hold the ink, and this he has now accomplished in a very remarkable degree. A certain amount of hand-work must occasionally be added, in order to correct the defects of the photograph, which sometimes gives undue force to the delicate portions of the original drawing; but, broadly speaking, the process is purely and wholly mechanical, and the copper-plate, as we have seen, is absolutely grown upon the raised print.

"There is scarcely any kind of original work to which this process may not be applied with success. In the reproduction of a drawing in pen and ink, the result resembles a strongly bitten etching. It is equally successful in imitating the effect of a drawing washed with a brush, or of a drawing in chalk; but as deposited copper is always more or less soft in substance, the plate, before it is used by the printer, is covered with a thin film of steel, and we have then a surface which is practically indestructible, and from which any number of impressions can be taken; for so soon as this thin film of steel shows signs of wear, the printer stops his labor, and the steeling is renewed. This process of steeling a plate is now very generally applied to engraved work on copper, and its effect is practically to abolish the distinction which once existed between proofs and prints. The value of a proof in former times consisted in the fact that it gave an impression of the plate in its full strength, before it had become worn by successive printings; but now there is in reality no limit to the number of impressions which can be taken from the steel plate, nor is there, as is sometimes supposed, any loss of the most delicate workmanship by the process of steeling."—*Photo. News.*

SIMPLE METHOD OF MIXING SOLUTIONS FOR ALKALINE PYROGALLIC DEVELOPMENT OF GELATINE PLATES.

By J. KAY.

I TAKE a bottle of pyrogallic containing one ounce of the acid, and add 14 drams of methylated spirit, which gives a concentrated solution, and may be labeled "Stock Solution," and one, I find, that keeps much better than a solution I used for many months, which was made the proper strength in the first instance. For ordinary use I take 2 drams of stock solution and dilute with 6 drams of methylated spirit, and keep in a wide mouth 3-ounce stoppered bottle. I find 1 ounce of this quite sufficient to have mixed at a time. I now have a solution which contains:

Pyrogallic acid	1 ounce.
Methylated spirit	7 ounces.

or rather, it would read thus if the whole bulk were so mixed.

If about to develop a half plate, I take ½ dram of this dilute solution and put into an ounce measure; or, rather, I have a ½ dram marked on my ounce measure, and pour the pyrogallic direct in, as pouring a ½ dram from one measure to another would not be a very profitable proceeding; I then add common water to make up 6 drams. The reason I use so small a quantity as ½ dram of pyrogallic solution is, that it is advisable, in saving time and water, to employ as small a quantity of spirit as possible. The strength of this pyrogallic solution when diluted with water as above mentioned is 2⅝ grammes to the ounce, which I find to be very suitable for studio work. For the ammonia solution I take:

Common water	80 ounces.
Liquid ammonia, 0·880 s. g.	1 ounce.
Bromide ammonium	6 drams.

6 drams of this solution added to 6 drams of the pyrogallic solution is ample for developing a half plate. I would strongly insist upon using a good proportion of bromide in the developer. It is a good preventive of green fog, besides giving clearness to the shadows of the picture and brilliancy to the negative. In cases where plates have a decided tendency to fog, I use double the amount already stated. I am aware that rapidity is to some extent sacrificed by a free use of bromide, but with me rapidity is only a means to an end. The great end in view is a good negative; everything else must be subordinate to that.—*Photo. News.*

PHOTOGRAPHIC PAINT FOR MACHINERY.

IT is a difficult matter to photograph a machine smoothly and effectively, and little success is likely to ensue unless the whole is first covered with a gray paint or wash. The *Photo. News* says that one of the best in use by photographers is the following:

Dry white lead	5 pounds.
Lamp black	2 to 5 ounces.
Gold size	1 pint.
Turpentine	1½ "

The amount of lamp black is varied according as a light gray or dark gray is best suited to the machine or the lighting. The paint is quite harmless, and is easily removed with turpentine rubbed on with a handful of cotton waste.

THE APPLICATION OF ELECTRICITY TO SHIPS' LOGS.

THESE are days of rapid scientific progress, and the great interest so recently excited by the application of electricity, in a new and startling way, to transmit information, has been almost eclipsed by the attention which its use for lighting and the transmission of power has attracted. Though no longer confined to signaling, yet this is still its most important use, and one for which its employment is being extended in many directions, always with the most satisfactory results. It is with the application of electricity, this fleet messenger, for giving a constant record of the rate of a ship that this article is concerned. Before, however, dealing with this matter, it will be well to say a few words about logs generally.

Ordinary ships' logs are of two kinds, called respectively harpoon and taffrail logs. Harpoon logs, which are the most extensively used, consist of a cylinder, on one end of which works a fan or screw, registering the number of revolutions by means of clockwork within the cylinder, the dial being visible through a glass face. To the other end, which is conical, a rope is fastened, so as to enable the log to be towed by the ship. A modification of this is called the "detached" log, the revolving fan and case for the clockwork being two separate pieces. To both these logs there are several objections, such as the almost unavoidable entrance of salt water to the wheelwork, the drag on the ship, which is often as much as 40 lb. or more, the inconvenience of hauling in the log each time it has to be read, and lastly, the loss of the whole instrument, should the towing line break.

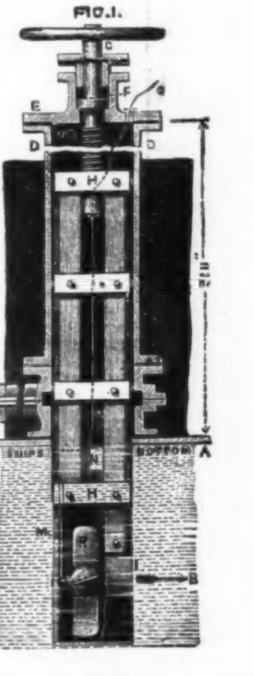
To obviate these objections, the taffrail log was invented, and which goes a step further than the detached log, by taking away the recording portion to the taffrail of the ship, and causing the towing rope to transmit the revolutions of the fan to it. These logs are, in many respects, a great improvement on the first; the registering dial is less liable to damage, and is always visible; the tension of the towing

line is less; it is therefore less liable to rupture, and even when this does take place, the fan is easily replaced. On the other hand, the unsuitable nature of the towing line for transmitting torsional force is obvious. Further, the slip of the fan must be seriously affected by the constant variation in length of the submerged portion of the line. In Walker's log these difficulties are partly met by the use of a governor, consisting of a pair of weights fixed to the towing line, and revolving with it; but this device can only modify the evil.

The late Mr. W. Froude, who pointed out other objections to existing logs, endeavored for some time to devise an electrical log, in which the revolutions of an accurately formed screw should be communicated to the deck, *not* by the revolution of the towing rope, but by an electric current in wires carried by it. Eventually he succeeded, in conjunction with Mr. Brunel, in constructing an instrument of this kind, which was applied to Sir W. Thomson's yacht, Lalla Rookh, and worked very well, till by some mischance it carried away and was lost. Mr. Kelway had, meanwhile, been working independently with the same end in view, and had constructed an electric log, which he brought before the notice of the Admiralty. A trial of this last instrument was undertaken by Messrs. Froude and Brunel, on board H.M.S. Shah. In this trial, the registering portion was placed on the poop, and self-recording apparatus was used, by which, at every revolution of the fan, a pen was lifted from a strip of paper moved by clockwork, thus causing breaks in the otherwise continuous line. On a line parallel to this, time in half seconds was simultaneously recorded. The result of this trial was to clearly demonstrate the satisfactory action of Mr. Kelway's log, and it was afterward applied, together with accurately formed fans, to H.M.S. Iris and the yacht Alberta. Its further extension has not been proceeded with, apparently in consequence of Mr. Froude's decease. Quite recently the same inventor has put into practice the happy idea of placing the electrical log to work altogether under the ship's bottom. The way in which this is done is shown in Fig. 1.

A water-tight case is securely fixed to the bottom plates, AA, in this case a frame, HH, is moved up and down, and

FIG. 1.



in the lower part of the frame the fan, R, works. The fan communicates its motion by a vertical spindle, M, to a box, N, in which electric contact is made and broken eight times in a mile. The wire, OO, can thus transmit a record of the distance passed over to a dial or dials fixed in any part of the ship.

This invention has the advantage of allowing the screw of the instrument to work in water of uniform pressure, and to a great extent free from the disturbing action of the waves. There is undoubtedly a body of water carried along by the surface friction of the ship. The depth to which this extends is unknown, but there is strong reason to think it is very small, and would not, therefore, affect the fan. The log itself, however, offers an excellent opportunity of investigating this obscure point, since it can easily be raised or lowered to different positions.

The complete instrument is at present being exhibited at the Crystal Palace Electrical Exhibition, and an account of its various applications has been recently given in a paper by Mr. Kelway. These applications are many and important, and the invention, besides being very suitable for its original purpose, promises to afford valuable information, not to be obtained by the use of ordinary logs.—H. S. H. S. —*Nature*.

ON THE ACTION OF THE MICROPHONE.*

By Prof. JAMES BLYTH, M.A., F.R.S.E.

IN the microphone transmitter, as usually employed in circuit with a battery and a Bell telephone, we have essentially two pieces of carbon resting lightly against each other, through which the current passes. That the instrument may work effectively, two things are requisite: first, that the carbons be always in contact or at least sufficiently near for the current to pass between them; and, secondly, that they may not be pressed together so tightly as to prevent any motion of the one relatively to the other. This state of things is sufficiently well described by the term "loose contact," first used, I believe, by Professor Stokes. To understand the action of the microphone, we have to find out what effects are taking place at the loose contact, when the instrument is acted upon by sonorous waves. These are twofold: first, the effect produced by the sound waves (that is, the variations of density due to the condensations and rarefactions of the air), which pass directly through the air when they arrive at the loose contact; and, secondly, the effect produced by tremors set up in the entire instrument, wooden supports and carbons together, by the sound waves which strike against it, and are thereby stopped.

For distinction we may call the first of these the air effect and the second the tremor effect. In my experiments, I have endeavored to arrange the instrument so as to isolate these effects, and, as far as possible, examine each of them separately. To isolate the air effect, it is obviously necessary either to fix their carbons rigidly in their supports, so as to avoid any motion of the one relatively to the other, or to use a strong current, and place them just clear of contact with each other.

The following experiment illustrates how this may be done:

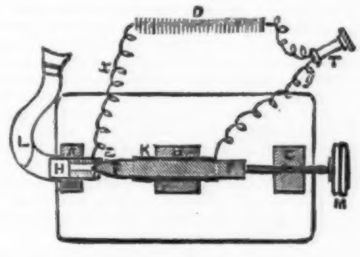
A, B, and C are three blocks of brass firmly fixed to a heavy wooden soleplate. To the top of A is soldered a piece of brass tube, H, about two inches long and five-eighths inch bore. To the top of B is soldered a piece of similar tube, K, about four inches long. Through C passes a fine screw, S, worked by a milled head, M. A piece of carbon-rod, E, is fixed firmly into H, and has a hole one-fourth of an inch in diameter drilled through its center. A long piece of carbon, F, pointed at one end, passes tightly through the tube, K, and can be moved backward and forward by the screw, S. A piece of india-rubber tube, L, is passed over the left end of the tube, H, and to this is attached a mouth-piece, M. By means of the wires, x and y, soldered to the carbon rods, they are put in circuit with the battery (twenty Grove's cells) and the telephone, T, which must either have a small resistance or be placed in a separate circuit from that containing the battery, so as to be acted upon inductively.

When the carbon, F, is screwed tightly into the hollow of E, the circuit is completely closed, and no sound uttered into M is heard at T. But when F is drawn gradually back until small electric arcs are seen to pass between F and E, every sound uttered into M is loudly and distinctly reproduced in the telephone, T. Here we have clearly only the air effect acting, and that solely upon the small electric arcs passing the carbons.

I have found it, as yet, somewhat difficult to get the sounds to last for any length of time, in consequence of the arc distance soon getting too great for the current to pass, and requiring readjustment. When the arc begins and ends, a sharp click is heard in the telephone; but in the interval during which the arc lasts, the sounds are distinct.

As far as the tremor effect is concerned, it is obvious that the microphone action must depend, either (1) upon the variation of resistance due to variation of pressure, or (2) to variation in the extent of surface contact due to the elastic yielding of the carbons under pressure.

To test the first of these causes, I made about two years ago some experiments on the effect of pressure upon the



specific resistance of carbon. For this purpose I took a short length of carbon rod, and soldered wires to it at a short distance from each end. By means of these wires the resistance of the carbon rod was balanced in the Wheatstone bridge. Pressure was then applied by means of a lever to the carbon in a longitudinal direction. No appreciable variation in the resistance was observed, even under considerable pressure; and it only became manifest when the pressure was sufficient to bend or crush the carbon. I have recently repeated these experiments with the greatest care, and found the same results. I observed also that similar experiments, with the same result, have quite lately been made by Professor Silvanus Thompson. Hence we can hardly, I think, believe that variation of specific resistance due to pressure can have the slightest effect in producing the microphone action.

To test the second cause above mentioned, that is, the variation of resistance due to variation in the extent of surface contact due to elastic yielding under pressure, I experimented as follows: In the apparatus already described, I replaced the tubular carbon by a finely pointed piece, so as to have two fine points exactly opposite each other. The resistance of the points was balanced in the bridge in the usual way. Pressure was then applied by a known number of turns or parts of a turn of the fine screw, and the change of resistance noted. The screw was then brought back to former position, and the pressure relieved, so as to allow the elasticity of the carbon to act and restore the points to their first condition. It is obvious that if the change of resistance were due merely to elastic yielding, it should now be the same as before. This I found not to be the case. From the gritty nature of the carbon, the points of contact, I found, were perpetually changing, hence the variation of resistance produced in this way obeyed no regular law. From this irregularity it is impossible, I think, to conclude that this cause could explain the transmission of musical sounds for less articulate speech.

As far as my experiments go, the following appears to be something like the true explanation of the microphone action. What I have termed the air and the tremor effects take place simultaneously. The tremor effect produces a jolting of the carbons sufficient to allow momentary minute electric arcs to take place between the points which are just clear of contact with each other. Simultaneously with this the air effect comes in, and on account of the variations of density due to the condensations and rarefactions of the air, acts upon the minute electric arcs so as to vary their resistance. The tremor effect explains merely production of the musical pitch of the sounds heard in the telephone, whereas it is to the air effect that we must look for the transmission of the quality of the sounds uttered into the microphone transmitter. The microphone is thus so far a delicate make and break analogous to the old Reiss transmitter, with the important addition, however, of minute momentary gaps filled with a material which is sensitive to the minute harmonic variations of the atmospheric density which constitute sonorous vibrations.

* A paper read before the Royal Society of Edinburgh.

ORIGINAL DISCOVERY OF THE DIPPING NEEDLE.

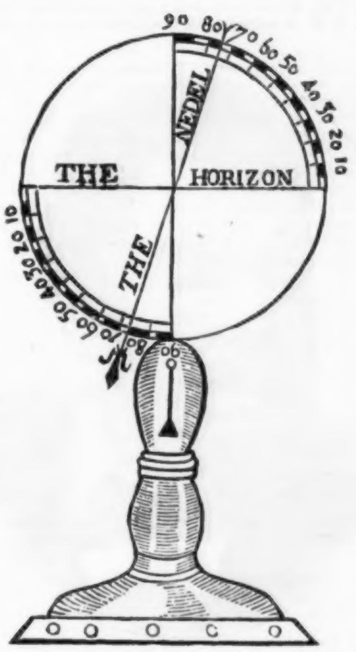
THE important discovery of the inclination, or dip of the magnetic needle was made about the year 1576, by Robert Norman, a compass maker, residing at Wapping, who in 1580 published a pamphlet entitled "The Newe Attractive, shewing the Nature, Propertie, and manifold Vertues of the Loadstone; with the Declination of the Needle, touched therewith, under the Plaine of the Horizon. Found out and discovered by Robert Norman." The sole credit of the discovery was awarded to him by Dr. Gilbert and Mr. William Burrows, contemporary writers on the subject of magnetism. The "Newe Attractive" was dedicated to Mr. Burrows, and Dr. Gilbert speaks of the author in the following terms: "This is that Robert Norman, that skilful Seaman, that ingenious Artificer, who first found out the Inclination of the Magnetick Needle." Mr. Bond also assures us, about a century after the invention, "That himself saw an Inclinatory Needle of one Dr. Merret's, which was made by this Robert Norman, A.D. 1576, and which he fitted up for the Doctor's use."

This curious pamphlet was reprinted in 1720 by Mr. William Whiston, and subjoined to a work of his own on the discovery of the longitude and latitude by the inclinatory or dipping needle. The following extracts, comprehending the third and fourth chapters of "The Newe Attractive," and containing the author's account of the discovery, in which the style and orthography are correctly preserved, will no doubt be acceptable to our readers. In the illustrative engraving which accompanies the fourth chapter, our artist has given a perfect facsimile of the rude cut contained in "The Newe Attractive:"

"CHAP. III.

"*By what meanes the rare and strange Declining of the Needle, from the plaine of the Horizon was first found.*

"Hauing made many and diuers compasses, and using alwaies to finish and end them before I touched the needle, I found continually, that after I had touched the yrons with the Stone, that presently the north point thereof would bend or *Decline* downwards under the Horizon in some quantitie:



insomuch that to the Flie of the Compasse, which before was made equall, I was still constrained to put some small peece of waxe in the South part thereof, to counterpoise this *Declining*, and to make it equall againe.

"Which effect hauing many times passed my hands without any great regard thereunto, as ignorant of any such propertie in the Stone, and not before hauing heard nor read of any such matter: It chaunced at length that there came to my hands an Instrument to bee made, with a Needle of sixe inches long, which needle after I had pollished, cut off at Just length, and made it to stand levell upon the pinne, so that nothing rested but onely the touching of it with the stone: when I had touched the same presently the north part thereof *Declined* downe in such sort, that beeing constrayned to cut away some of that part, to make it equall againe, in the end I cut it too short, and so spoyled the needle wherein I had taken so much paynes.

"Hereby beeing stroken in some choller, I applyed my self to seeke further into this effect, and making certayne learned and expert men (my friends) acquainted in this matter, they advised me to frame some Instrument, to make some exact tryal, how much the needle touched with the stone would *Decline*, or what greatest Angle it would make with the plaine of the Horizon. Whereupon I made diligent proofes: the manner whereof is shewed in the Chapter following.

"CHAP. IV.

"*How to finde the greatest Declining of the Needle under the Horizon.*

"Take a small Needle of Steele wier, of five or sixe inches long, the smaller and the finer mettall the better, and in the middle thereof (crosse the same) by the best meanes you can, fixe as it were a small Axeltree of yron or brasse, of an inch long, or thereabout, and make the ends thereof very sharpe, whereupon the Needle may hang levell, and play at his pleasure.

"Then provide a round plaine Instrument like an Astrolobe, to be divided exactly into 360 partes, whose diameter must be the length of the Needle, or thereabout, and the same instrument to bee placed uppon a foot of convenient height, with a plumme line to sette it perpendicular.

"Then in the Center of the same Instrument, place a peece of Glasse hollowed, and against the same Center uppon some place of Brasse that may be fixed upon the foot of the Instrument, fit another peece of Glasse, in such sorte that the sharpe endes of the Axeltree beeing borne in these two

Glasses the Needle may play freely at his pleasure, according to the standing of the Instrument.

"And the Needle must be so perfected, that it may hang upon his Axletree both ends levell with the Horizon, or beeing turned, may stand and remaine at any place that it shall be sette: which being done, touch the saide Needle with the *Magnes* stone, and set the Instrument perpendicular by the plumme line, and turne the edge of the Instrument South and North, so as the Needle may stand duley according to the *Variation* of the place: which *Variation* the Needle of his owne propertie would shew, were it not that he is constrained to the contrarie by the Axeltree.

"Then shall you see the *Declination* of the North point of the touched Needle, which for this Citie of *London*, I finde by exact observation to be 71 degrees 50 minutes. The forme of the Instrument heere described with the manner of the declination, I have heere placed that it may be the easier conceived."—*The Electrician.*

DR G. W. SEPTIMUS PIESSE, PH.D.

WE regret to have to record the death of the genial principal of the house of Piesse & Lubin, the perfumers, of Broad Street, London.

George William Septimus, seventh child of the late Charles A. J. Piesse, chief clerk in the War Office, was born on May 30 1820, and died on October 23, 1882.

His early education was limited to such as is generally within the power of a grammar school to impart, but his taste for scientific amusements drew him on to study the science of optics as a serious occupation, and notwithstanding the fact that he served no manner of apprenticeship, he started life as a practical optician. Want of capital, however, prevented his business from being extended as his ambition required, and we see him a few years later as pupil to Professor Graham, attending the lectures of that eminent chemist at University College. As a student he made his mark and secured the friendship of his teacher—a friendship which remained unbroken up to Dr. Graham's death.

Pursuing the study of chemistry, he subsequently practiced as an analytical chemist, and for a time with considerable success, but, professional occupation falling off, he again turned his attention to trade, and entered the house of Messrs. J. & E. Atkinson. A few years later an offer by

SEPTIMUS PIESSE.

Mr. Breidenbach of higher remuneration induced the subject of our memoir to secede from Messrs. Atkinson and enter upon new services with the late Mr. Breidenbach, with whom he remained for some years.

Mr. Piesse was an adept in the art of conjuring, and a skillful prestidigitator, a power which was the means of putting him finally upon the road to fortune, inasmuch as it brought him into contact with the gentleman with whom he founded the firm of Piesse & Lubin.

In the art of perfumery he opened up a new era by Anglicizing it; before his time, perfumes, like gloves, were considered below par unless foreign names were used in their identification. He, as do all men of original ideas, met with acrimonious criticism bordering upon abuse. He lived it down, however, and to-day Kiss-me-Quick perfume is considered no more vulgar than "Parfait Amour" liqueur, or a song entitled "Kiss me once again." He endeavored for many years to promote the cultivation of perfume bearing plants in the British colonies, and succeeded in inaugurating numerous extensive experiments, which are still in progress. His earlier hopes in this direction were greatly buoyed up by his trust in the power and influence of his elder brother Charles, who then held an important office in the Colonial Office, but whose premature death doomed those hopes to be blighted.

He was one of the earliest associates of the Chemical Society, before whom he read several original papers. He was the author of many well-known works, among others "The Art of Perfumery," "Piesse's Magic," "Laboratory of Chemical Wonders," "Twenty Letters on Farming" are from his pen, and he contributed many articles on perfumery and kindred industries to the *Scientific American* and to various cyclopedias.—*Chemist and Druggist.*

GUM ARABIC IN CHEMICAL REACTIONS.

By MM. JULES LEFORT and P. THIBAULT.

IN dilute solutions gum hinders the precipitation of metallic sulphides. In concentrated solutions, or when the proportion of gum is small, there is precipitation more or less incomplete. The precipitation of the metallic oxides is also prevented while in presence of gum, quinine, cinchonine, morphine strychnine, brucine, and veratrine are not precipitated by the usual reagents, ammonium phosphomolybdate, potassium-mercury iodide, and tannin. The gum does not dissolve the various precipitates formed or prevent their formation, but merely holds them in suspension. These results have a certain physiological importance. Most inorganic fluids contain glutinous bodies, and it is hence possible to understand the simultaneous presence in a soluble state in the animal and vegetable cellules of compounds capable of acting chemically upon each other. In analytical operations, gum and analogous bodies must be removed before certain determinations can be effected.

ARTIFICIAL PRODUCTION OF WITHERITE, STRONTIANITE, AND CALCITE.

L BOURGEOIS has found that the carbonates of barium, strontium, and calcium can be easily crystallized under the ordinary pressure in a bath of certain fused materials. That which has given the best results consists of a mixture of equal equivalents of the chlorides of sodium and potassium. This mixture fuses at dark red heat, and if a few decigrammes of precipitated carbonate of barium, strontium, or calcium be added to the fused mass, the salt is seen to sink to the bottom of the crucible without the least effervescence. After a few minutes the fused mass is allowed to cool, and the chlorides of sodium and potassium dissolved by washing with water, when there are obtained fine crystals of carbonate of barium, strontium, or calcium, identical in their chemical composition and physical properties with the natural mineral species. The carbonate of barium is generally found in hexagonal plates, which, under a microscope, exhibit faint polarization colors. The carbonate of strontium has only been found in the form of elongated prisms with very marked double refraction, and the carbonate of calcium constantly presents an assemblage of crystals resembling those of snow. When placed under a microscope, these hexagonal stars appear colored, and if convergent light be applied, they show a black cross completely surrounded by circular rings.—*Comptes Rendus*, xciv., 991.

THE AIM OF INSTRUCTION IN TECHNICAL CHEMISTRY.*

By WATSON SMITH.

THE Royal Commission on Technical Instruction have wisely divided the subject at the commencement of their first report, recently published as follows: First. The instruction of the proprietors and superior managers engaged in industrial pursuits. Secondly. That of the foremen engaged therein Thirdly. That of the workmen. I need scarcely say that it is with the first of these we have to deal—for, according to the very plan of this college, it is evidently the higher development of technical scientific training which must be the aim here. Technical, technological, or applied chemistry is the science of chemistry applied to the manufacture of certain commercial substances or to the carrying out of certain operations and processes. It is an offshoot from the parent tree of pure chemistry, and the analogy will bear further development, for as the branch, like the rest of the tree, draws its life and nourishment from the root, and so it can neither live nor yield fruit apart from the tree, so, separated from the pure science, any branch of operations depending upon chemistry must in the end prove a dead and fruitless thing. In like manner, if you lop off the branch and attempt to raise fruit, by applying foreign matter by way of nourishment and life instead of the natural, this effort will equally fail; and so if "rule of thumb" govern where chemical science should be the ruling and guiding principle, the result must be failure. How much time, strength, and money have been wasted in disregarding this truth by manufacturers and patentees who have blindly and uninstructedly endeavored to wield forces the nature of which they knew little or nothing of.

In the manufacture of chemical products raw materials of various kinds are employed. Likewise in the operations themselves apparatus and machinery are required which further require a special and suitable building and arrangement, and hence the chemical knowledge should be wedded to an acquaintance with a certain amount of engineering. But the raw materials used may be of mineral or vegetable origin, therefore it is clear that our model chemical engineer, if his education is to be complete, should also be acquainted with the elements of geology and mineralogy, and even botany, in addition to those of mechanical engineering. Of necessity, furthermore, he should be acquainted with the languages of Continental countries, such as French and German. The modern theoretical chemist requires, first, a general and at least elementary mathematical foundation, and safely building upon this, the only secure groundwork, his knowledge of chemistry and natural philosophy, he will soon find how readily the two become united into one structure. I need only point out further that the mathematical foundation is indispensable for making any useful advance with mechanical engineering Thus it appears that a true course of technological chemical instruction must include a number of branches, among which that of scientific chemistry stands pre-eminent.

Now, as regards the study of applied or technological chemistry, I must here disclaim, however, any pretensions of teaching such details of a manufacture as to arm the student completely with all the requisites to enable him to be a successful manufacturer. I fully agree with those who say, "A trade can only be thoroughly taught in the workshop," and I adhere to this after from eight to nine years' practical experience in almost every position of responsibility in various chemical factories. The amount of detail in even the simplest well conducted manufacture is far beyond the scope of class instruction, to say nothing of important commercial habits and knowledge. Technological chemistry is, as it were, a kind of borderland before entering the region of actual practice, and here should be learned the closer application to special manufacturing branches of the training he is enjoying.

Another fact also appears, namely, that the student can only be adequately guided through this borderland and stage by one who has been himself in actual working practice in the manufactories. The fact is, in teaching this subject a special atmosphere, so to speak, of practical experience, only to be gained by actual living contact and association in the workshops themselves, must be made to surround and envelope the teaching and application. As an illustration of this, taken from a subject in which applied inorganic chemistry is concerned, we find in general terms in our text books on theoretical inorganic chemistry, on the subject of the sulphuric acid manufacture, that this acid is prepared in large chambers lined with sheet lead, and how it is afterward concentrated by heating in leaden vessels. This is perfectly right—sufficient to elucidate clearly the chemical principles involved. As soon, however, as the subject is approached in a practical light, the principles of economy must be strictly regarded—in fact, must govern. The key-note is no longer "Truth for its own sake merely," but rather, "Truth for the maximum tangible profit it can be made to yield;" and now, returning to the point, it may be observed as follows:

CURIOUS FACTS ABOUT LEAD.

The statement that sheet lead is employed for vitriol chamber sides or for evaporating vessels, is true enough as a general scientific fact; but the question of great moment to the manufacturer who finds his chamber sides and bottoms and evaporating vessels gradually becoming attenuated and disappearing is, "Have some classes of lead more resistance to the action of sulphuric acid than others?" also, "Under what conditions is this resistance increased or diminished?" Two Manchester chemists and manufacturers, Dr. F. C. Calvert and the late Mr. Richard Johnson, solved this problem, and found that lead is all the more easily attacked by sulphuric acid the purer the lead is, and that the resisting power of the ordinary commercial sheet lead is due to the presence of mere traces of tin and copper, most especially the former. By more recent observers it was found, further, that the lead which contained small quantities of antimony is more resisting, but with small quantities of bismuth the resistance of the lead is considerably diminished. Finally, sulphuric acid chambers are constructed of a special kind of sheet lead supplied here in the North by certain rolling mills, as so-called "chemical lead," which is made from scrap lead melted up in the alkali works themselves, and which contains many impurities, especially antimony.

But let it be observed, the facts just mentioned, of so much technological importance, were discovered and only could be discovered by means of a purely chemical investigation. Neither "rule of thumb" nor guess-work could settle this point. Many English manufacturers I know say, 'It cannot be necessary that a young man contemplating entering a chemical works, aiming at becoming a chemist, manager, or proprietor, should go so deeply into the theory and practice of chemical science as you indicate, for, remember, *we* don't want a scientific man, but some one who just knows enough chemistry to work our processes profitably, and, if necessary, improve them." Now I can undertake to prove to you, I would reply, that if it be essential for a student of scientific chemistry, aiming at eminence in the pure science, to pass through a certain thorough course of chemical study, it is desirable that a student of technological chemistry, who really wishes to make his mark, should pass, *if possible*, through even a still more stringent course. I will give example and proof of this.

ARTIFICIAL INDIGO.

The discovery of the method of preparing artificial indigo was made by a purely scientific chemist, Professor Baeyer, of Munich, perhaps the first chemist of the day. The process was patented, and artificial indigo is manufactured in the Badische Soda und Anilin Fabrik in Ludwigshafen. But the yield of this coloring matter from the materials used is not exactly what could be desired. The manufacture cannot as yet be said to pay satisfactorily, and the chemists of the Badische Soda und Anilin Fabrik, with Dr. Caro at their head, are laboring earnestly to find such an improvement in, or modification of the method, as shall give an increased yield. But Dr. Caro and his assistants, in seeking to improve upon the work of Professor Baeyer, must plainly be able readily to repeat and follow out his chemical reasoning, and to go further, and so modify or alter his methods as to obtain an increased yield of color, *i. e.*, to make the process a commercial success. Of course, Professor Baeyer is himself at work with the same view upon his method, and the subject is really one of the most difficult problems in modern organic chemistry. If success attends the efforts of these chemists, our indigo plantations in India may possibly share the fate of the madder plantations of Turkey, the south of France, and elsewhere, since the discovery of artificial alizarin by Graebe and Liebermann in 1869.

Of course, I admit that the science of chemistry may also assist in the more profitable extraction and manufacture of the natural product. Here, then, is the warrant for my assertion, that, far from a technological chemist devoting less time and pains to thoroughly mastering the theory and practice of pure chemistry, he ought to be thoroughly versed in the science.

But it may be objected, you have quoted exceptional cases to carry your assertion—indigo and alizarin are substances of exceptionally complex chemical structure, and their investigation demands exceptional ability and skill. Well! let us then return to the alkali manufacture, and look at the list of names of those who have wrought all the grand improvements of late years, and we find Mond, Schaffner and Helbig, Hargreaves, Hurter, Solray, Weldon, and Balmain, all living testimonies to the fact that none but well-trained chemists can hope nowadays to achieve any real success in attempted improvements in this branch of manufacture. The deep meaning contained in the otherwise somewhat curt reply of Professor Baeyer, of Munich, when questioned as to the time he would keep a technological student studying and working at theoretical chemistry, during his course of training, will now be apparent; he replied, when thus questioned by the Royal Commissioners, as Professor Roscoe informs me, "I should make it, first, chemistry, secondly, chemistry, and thirdly, chemistry," which, I apprehend, may be interpreted, "Add the suitable attendant and subsidiary branches of study as you may or can, but keep throughout the stream of chemical instruction and practice flowing steadily."

In conclusion, how far is it advantageous to specialize in the several industries in our teaching? *E. g.*, Are we to erect small soda works? Are we to set up a brewing plant? This would be absurd. In a similar way the erection and arrangement of a dye-house, in which materials are to be colored economically, is again clearly beyond our sphere. Much may be, however, said in favor of dyeing schools, provided always the underlying principles have been firmly established; and I believe, for example, the dyeing school of the Yorkshire College, at Leeds, is both doing good work and has a sphere of usefulness before it; and the same may be said of the newly established school, on a lesser scale, in the Mechanics' Institute, Manchester. I fall back upon the very first sentences of this lecture, namely, to the division adopted by the Royal Commissioners, and just point out that our course for masters and managers here is simply too full to allow the barest possibility of time being found for such instruction, otherwise all very well in its way and place. That would be a good course for intelligent and instructed foremen and workmen, who, on the other hand, could certainly not find time in their course to obtain any-

* Abstract of introductory lecture delivered by Mr Watson Smith, F.C.S., editor of *The Journal of the Society of Chemical Industry*, at the commencement of the evening session 1882-83 in the Owens College.

thing like the education of the masters and managers who are willing to wait for the working details and special technicalities and experience, and must prepare themselves to become the heads and brains of the concerns where they will eventually settle down.

ACROCLINIUM ROSEUM.

THE single Helipterum (*Acroclinium roseum*), a native of Texas, was imported into Europe not so very long ago, and immediately gained the favor of nearly every one who saw it.

THE DOUBLE ACROCLINIUM.—FLOWERS ROSE COLORED.

Especially the bouquetists and wreath-makers found it to be a very good addition, and used the little pink-colored flowers freely to fill baskets, arrange bouquets, and for general flower-work. Six years since I discovered among the Acrocliniums, which I cultivated on a space of ten to twelve acres, a few plants, the flowers of which showed a slight inclination to become double. These few plants I picked out,

THE SINGLE ACROCLINIUM.

and with the greatest care I selected again and again the proper plants, so as to obtain a double flower.

I have now succeeded in getting this novelty nearly constant. Only about 25 per cent. of the seeds sown last harvest from good double flowers turned out single flowers. After a period of six years' unceasing care, I offer my new Acroclinium roseum flore pleno (J.C.Schmidt) as a very valuable addition to the class of everlasting flowers.

The single Acroclinium being a very favorite flower, without which the composition of flower-work cannot be effected, the new *Acroclinium roseum flore pleno* will doubtless

HELIPTERUM (ACROCLINIUM) ROSEUM FLORE PLENO.

obtain still more favor from consumers, as in the case of the forms of Helichrysum and Xeranthemum, of which flowers the double varieties are always preferred to single ones.

The demand for material to make wreaths and bouquets of dried flowers is increasing from year to year and every good novelty in this department is generally accepted with great satisfaction.—*J. C. Schmidt, Erfurt, in The Gardeners' Chronicle.*

DEUTZIAS.

THERE are few more ornamental shrubs than these. They have the advantage of being hardy, very free flowering, easy to propagate, and requiring next to no attention. Some of them form excellent subjects for forcing. Their leaves are covered with star-shaped bristly scales, which form very pretty objects under the microscope, and are readily

DEUTZIA CANDIDISSIMA, HORT.—HARDY SHRUB. —FLOWERS PURE WHITE.

visible with an ordinary pocket lens. Our figure of *D. candidissima* represents one of the most beautiful of a beautiful genus.—*The Gardeners' Chronicle.*

THE LENTIL.

(*Lens esculenta.*)

A GOOD deal of interest attaches to the lentil in consequence of its great antiquity as a food plant; it is generally supposed that the lentil used in the pottage Jacob gave to Esau was identical with the lentil of the present day. Lentils were undoubtedly cultivated to a very large extent in the East in very early times, and they continue to be so grown throughout Egypt, Nubia, Syria, and India. In central and southern Europe also the lentil is cultivated as a food plant. Its introduction into this country is said to date from about the year 1548, but its cultivation with us on a large scale has never been attempted. There are many varieties grown, varying in habit, but more particularly in the size, shape, and color of the seeds, the usual form of which is circular, about one quarter inch across, concave on both sides, and of a dark-reddish or chocolate-brown color. Others, again, are not more than a third the size, more

LENTIL (LENS ESCULENTA).

globular, and often of a pink tinge; these are largely grown in India. The lentil is an annual, seldom exceeding one foot or eighteen inches high, belonging to the papilionaceous section of the pea family (*Leguminosæ*); its flowers are pale blue, and its small pods contain one or two seeds. In some Continental countries the lentil is grown as much for the sake of the haulm as for the seeds, the former being used both in a fresh and dried state for feeding cattle, particularly young stock. When given as green food, it should be cut when the first pods are nearly full grown, and in this case it is generally sown broadcast, but drilled when grown for ripe seeds. The soil best adapted for the lentil is that of a dry, light, calcareous, sandy character, being very impatient of wet. Though not cultivated with us as a crop, it has been recommended by many as yielding a large supply of very nutritious food.

Lentils are cooked in a variety of ways; with the outer skin removed, and the seeds reduced to fine flour or meal, they form an easily digested food, often recommended for invalids. The "Revalenta Arabica," so much advertised, is largely composed of lentil meal. The principal mode of using lentils, however, is in soups in the way in which split peas are used. Considerable quantities are annually imported into this country.—*J. R. J., in The Garden.*

THE PEA NUT.

(*Arachis hypogæa.*)

THIS little annual is interesting not only on account of the very large quantity of oil contained in its seeds, and which is so largely expressed for commercial purposes, but also on

THE PEA NUT.

account of its peculiar habit of ripening its seeds beneath the surface of the ground instead of above it. The plant forms an erect, thick, angular stem, one foot or more high, and bears long, stalked alternate leaves with two pairs of opposite leaflets of a lightish green color. The flowers are papilionaceous, golden yellow, and crowded together in the axils of the lower leaves, or solitary. The pod, which is formed at the apex of the stiff reflexed stalk, is pushed beneath the ground in a very young state; the ovary, indeed, remains very small for a long time, forming apparently only a blunt point to the stalk, which is covered with a hard cap to enable it to force its way in to the ground, which it does to the depth of two in. or three in., and it is not till it has so buried itself that the ripening of the fruit commences. If anything occurs that the ovary does not become thus buried, it does not increase in size, and consequently the seeds are not formed. The usual number of seeds in a pod is two, but three are not unfrequent. The oil expressed from these seeds is used in all countries where the plant is cultivated, either for culinary purposes or for illumination.

Enormous quantities both of the seed and the expressed oil are brought together to this country as well as to Marseilles, Hamburg, Berlin, and other places. At Marseilles more particularly, the ground nut forms at the present time a very important article of commerce. Arachis oil is used both as a substitute for and as an adulterant of olive oil. The seeds are eaten either raw or roasted. They have also been used as a substitute for coffee and even for chocolate when beaten in a mortar; indeed, one writer on North American products says: "The manufacture of chocolate cakes out of ground nut alone, without a particle of cocoa, is an immense and most profitable part of Northern manufacture."

The native country of the ground nut is not accurately known. It is cultivated to an enormous extent throughout the tropical world in Africa, Asia, and America, but it is not known in a truly wild state. It has been suggested, however, that it may probably belong to Brazil, to which country the other species of the genus belong. It may be raised from seeds, and is not unknown in our botanic gardens. It flowers in July and August.—*J. R. J., in The Garden.*

ALPINE OR FOUR SEASON STRAWBERRY.

WHEN one takes into consideration what a popular fruit the strawberry is, one may reasonably feel surprised that no serious attempt has hitherto been made to extend its fruiting season. As a fact, strawberry time is far too short,

FOUR SEASON STRAWBERRY.

coming to an end just when a good supply of fruit would be most acceptable; and what makes the matter even worse is that the best late kinds are not so prolific as one could desire. Take, for instance, the British Queen, the finest flavored variety we have; and yet few grow it, simply because it is so exceptional in its requirements as to render it of but little value for general culture. The same remarks also apply to Frogmore Late Pine. What we need is a variety

that would come naturally into fruit in the latter end of July. Some few years ago it really appeared as if in Perpetual Pine we had secured just what was required. It was soon found, however, to be too shy a flowerer to be of much use, for although it maintained the perpetual bearing character given it, it never yielded fruit enough to make it a paying kind. It might, however, be made the means of obtaining for us what we need if crossed with some free bearing kind, such as Vicomtesse Hericart de Thury, which evinces a strong tendency to produce fruit late in summer and in autumn, or perhaps Sir Harry, which exhibits a like inclination to flower successionally throughout the summer.

Failing a large-fruited, well-flavored productive kind, we have the little Alpine, or what the French fittingly term the four season, or every month strawberry; and if we can get rid of the notion that a strawberry may be wholesome and refreshing without being large, we shall find that this small-fruited variety will fulfill our requirements as regards a supply from the time our main crops are over. In French gardens the four season strawberry is held in high estimation, fruit of it being obtainable all through July, August, and September, while to the market gardener it affords a welcome source of revenue at that time of year. So great is the love of the French for strawberries, and so constant is the supply throughout the season, that the strawberry man is as familiar a figure and as much an institution in French towns as the watercress man in the streets of London, making his rounds in early morning with his fruit neatly packed and temptingly displayed in large baskets having many compartments, so that it comes to the purchaser in a fresh, unbruised condition. This is certainly one thing they do better in France than in England, a fact we should do well to recognize, for certain it is that a good supply of strawberries in August and September would be appreciated by all classes in this country.

The culture pursued in France for the production of late summer and autumn crops is simple enough, as by cutting off the flower stalks which appear in spring, varying the time somewhat, so that the whole of the beds are not cut over at once, the fruiting season of the plants thus operated on is thrown back a month or more. The best practice, however, consists in taking the first of these late crops from the established plantations, planting out good runners in October for succession, as these are found to be more free and productive in late summer than such as have previously yielded fruit, while the autumn gatherings are taken from seedling plants raised early in March in warmth, and pricked out in cold frames until large enough for the open air. The beds for these young plants are very carefully prepared, being well stirred and made very rich by the addition of old hotbed manure. Generally the beds are about 4 feet wide, as this affords convenience for weeding and watering, and also gives great facility for gathering the fruit. If during dry weather abundance of water is given, the plants will make free and rapid growth, and will yield abundantly till late in autumn. I should mention that there exists a variety which does not differ from the true kind as regards fruit and habit, but which does not produce runners.—*John Cornhill, in The Garden.*

ANALYSES OF FOOD.

In a long and interesting article in the *Pharmaceutische Centralhalle* on the nourishing powers of various natural and artificial foods for infants and invalids, Dr. Stutzer, of Bonn, gives the following results as far as concerns their nitrogenous constituents:

	Flesh Formers, per cent.		Flesh Formers, per cent.
Caviare	25·81	Condensed milk	8·79
Ervalenta	19·93	White bread	7·20
Smoked ham	18·92	Biscuit	6·71
Fresh beef	18·53	Oysters	5·78
Fowl (breast)	16·56	Cow's milk	4·00
White of egg	13·48	Extractum carnis	3·40
Yolk	13·01	Malt extract	0·28
Infants' food	9·90		

The above table gives rise to some curious reflections. The wonderful nourishing powers attributed to oysters are found to dwindle into insignificance when compared with other food; for instance, a single hen's egg contains as much nourishment, that is to say, as much flesh forming material, as fourteen oysters, while a quarter of a pound of lean rump steak is equal to about five dozen of these delicious but delusive mollusks.

With regard to condensed milk, it contains much less flesh forming material than is generally supposed. Taking four per cent. for cow's milk as a fair average, the directions on the cans, if followed out, give unexpected results. For children's use, we are told to dilute the condensed milk with four or five parts of water. Taking the lowest figure, we should then have five parts of diluted condensed milk, which, according to Dr. Stutzer's figures, would only contain 1·76 per cent. of flesh formers, instead of four per cent., while the milk sugar would be increased from 4·5 to 10·85 per cent. We know that woman's milk contains more sugar than cow's, but still not in the above surprising proportions. Now that so much canned milk is used for infants brought up by hand, it becomes a question how far mothers who cannot suckle their children are responsible for the health, and even lives, of their children, by giving them milk from the tin cow instead of that of the living animal.

Dr. Stutzer's figures also further expose the often-exposed superstition about the nourishing powers of beef tea. He extracted all the extractible matter from 100 grammes of beef with 100 grammes of water, and a good proportion of salt, at a gentle heat for four hours, but could only succeed in obtaining in solution one twelfth of the nourishing matter of the beef, the remaining eleven-twelfths remaining behind in the *bouilli*. In other words, we should have to take half a gallon of beef tea made with a pound of beef and a pint of water before we got as much nourishment as is contained in a quarter of a pound of steak. We might, it is true, evaporate our beef tea down to, say, half a pint, but we doubt if it would be palatable to the least squeamish invalid. The high value of eggs, too, is well shown; in fact, roughly speaking, a couple of eggs weighing three and a half ounces are about equal to two ounces of good rump steak.

Dr. Stutzer, in the course of his article, mentions three samples of cocoa warranted free from fat (*entölter Cacao*), from different houses, which contained, respectively, 33·48, 32·31, and 30·95 per cent. of fatty matter of some sort!

The highly nourishing powers of caviare will no doubt strike the "general" with amazement.

With the law of libel in its present condition we have been obliged to omit names, but Dr. Stutzer either has not the fear of the law before his eyes, or they "order these things"—legally, at least—"better in Germany."—*The Chemists' Journal.*

NEW ANTI-FAT REMEDY.

By G. HOLMES, M.D.

ABOUT a year ago Dr. M. Milton, of Bradford, Pa., called the attention of the profession to the value of powdered extract of gulf weed in the reduction of corpulence or excessive accumulation of fat. I could not find the remedy in the drug stores or mentioned in druggists' circulars. I believe it is a French preparation, recently introduced into this country. I wrote to Dr. Milton, who indicated the source of supply. The price is high, about five dollars per pound, but the dose is small. I usually prescribe five grains every two hours, but in the absence of any reliable preparation that will do the work it does, it is cheap.

One patient weighing two hundred and forty-six pounds was reduced in eight weeks to one hundred and ninety-six.

This was my first and most remarkable case. No particular attention was paid to dieting, but abstinence from fluids as much as convenient was insisted on. This patient was troubled with hemorrhoids, which were cured, the extract being an aperient, the removal of the fat from contiguous parts relieving the congestion.

One patient from a distance, for whom I prescribed, was so pleased with the results that she requested my photograph. I expect a proposal of marriage next. One lady says I should not die without making my secret known. If I have any, this is to comply with her request. I might add many of the kind words I have received for my success in reducing the hills of flesh to comfortable proportions, at least.

The general health improves; strength is gained under the use of the remedy.

It is the wealthy corpulent ladies that sigh for relief. The good living and indolent habits predispose to it, and many of them would give a pound of gold for every stone of fat lost.

I have prescribed for thirteen cases during the past year; the average amount of reduction is from two to five pounds per week, two to three without dieting, from three to five with dieting, *i. e.*, abstaining from fats, starchy and saccharine fluids. The amount of reduction does not occur during the first week or two, but after this period the reduction is rapid. Any one persevering six weeks will not regret the trial.

I have been disappointed in *Fucus vesiculus*, sea water, mineral waters, liquor potassæ, alkalies, arsenic; all of these produce results worse than the healthy obesity.

This subject is one of great interest, as may be inferred from the fact that nearly one hundred thousand copies of Banting's pamphlet were printed in the English language alone.—*Medical Brief.*

Our corpulent friends may be interested in the report of Mr. Joseph Harrass's attempts to get rid of his superfluous burden of flesh, especially as the dietary followed does not seem, on the face of it, to be an objectionable one, and has not proved injurious to health in his case. The facts are stated in the *Herald of Health* as follows:

He was corpulent, had irregular and feeble action of the heart, tendency to fainting, difficulty of breathing, and many disagreeable sensations in the head indicative of nervous exhaustion. Height, five feet six inches; normal weight, one hundred and fifty pounds; age, fifty nine; weight at beginning of treatment, two hundred pounds. Began treatment, October 8. Treatment as follows: Breakfast—vegetables, brown bread (toasted), water, with lemon-juice, and occasionally oatmeal. Dinner—vegetables, brown bread, water, and plain pudding. Supper—brown bread (toasted), stewed fruit, and water. No tea, coffee, cocoa, or milk, except skimmed, and only a trifle of butter.

Result:	End of October weighed	187 lb.
"	November weighed	182 "
"	December weighed	177 "
"	January weighed	174 "
"	February weighed	173 "
"	March weighed	170 "
"	April weighed	168 "
"	May weighed	166 "
"	June weighed	166 "
	Present weight	150 "

All the distressing symptoms have been relieved, and the patient is so well that he can again carry on his business. His physical and mental strength have been greatly increased.

Mr. Harrass says he has suffered no serious discomfort from his diet, except when away from home, and he feels as if he had learned an important lesson as to how to reduce his corpulence—which has been such a source of discomfort—and once more enjoy life.—*Boston Journal of Chemistry.*

HUMAN FOOT PRINTS FOUND IN SOLID ROCK.

THE Nevada State Prison, at Carson, is situated on a sand-stone spur, which runs out from the Pine Nut Mountains into the Carson Plains, like a great promontory. The prison quarry has uncapped the spur to a depth of from thirty to forty feet, and exposed a layer of arenaceous shale. In this shale, and covering a space of about an acre and a half, have been found a large number of tracks, both of animals and birds, and what are supposed, also, to be human foot-prints. Eight great square impressions, twenty by twenty-two inches in size, showing a stride of four and a half feet, come out from the superincumbent rock. These have been supposed to be the tracks of the mastodon, or mammoth. Tracks of a wading bird are also seen along with it. What is more remarkable, however, is that a number of foot-prints, such as a giant man would make, if shod with thick-soled moccasins or sandals, have been found. There are six series of them, the foot-prints numbering from eight to seventeen inches in each. The size of the sandal is as follows: nineteen inches in length, eight inches broad at the ball, six inches at the heel, having a length of stride two feet three inches. The distance between the feet, or straddle, is eighteen inches. Most of them have straight-pointed toes, supposed to distinguish the white man of to-day. In no case is the naked foot distinctly shown. In all the tracks the toes turn outward.

This discovery, with that of the Calaveras skull, will, no doubt, be seized upon as direct proof that man existed in the Tertiary, as early as the Miocene. From these papers it appears that several quite distinct tracks of deer are to be seen, some which resemble those of a wolf, and abundant tracks of wading birds, which do not differ from those of the same class now living. The rock above the tracks is fifteen feet in height, and gives evidence of having been at one time the shore of a local or isolated lake. Its level is above that of Lake La Hontan, which itself is, as is well known, an ancient basin, now empty, but was, in the Pliocene age, the bed of a great lake or fresh-water sea. These tracks antedate the present river-system of the Sierras, and must be very old. It seems to be uncertain whether the rock belonged to the Quaternary or Tertiary, but it is more uncertain whether they are human foot-prints or not. Papers were read before the California Academy of Science by Dr. Harkness and Mr. Gibbs, both of whom seemed to think that the tracks are doubtless human.—*American Antiquarian.*

IRIDIUM.

IRIDIUM is melted by heating in a Hessian crucible with phosphorus, and subsequent removal of the phosphorus by repeated fusion with lime. The metal, in very thin sheets, can be cut by a copper wheel, making 2,000 revolutions per minute, and having its surface covered with emery, or corundum and oil. Metallic iridium is nearly as hard as ruby; no steel tools make any impression on it; attempts have been made, with fair success, to use it in place of carbon as the negative pole in the electric arc light.

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